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THE

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THE MEDICO-LEGAL ASPECT OF X-RAYS.

WITH a widening field of usefulness the medical employment of X-rays becomes a "burning question," and this in its most literal sense. It is true that, so far as the X-ray photograph—the "radiograph"—is concerned, an improved instrumentation has so far shortened exposures that the harmful, inflammatory effect known as X-ray "dermatitis," or "X ray burn," need not be apprehended. A five minutes' exposure ought to be sufficient for the most deeply lying organs of the body; and this with the tube at 7 in. from the skin involves no risks—whatever be the construction and condition of the tube, the penetrating power of the rays, the number of interruptions, the size of the secondary coil, or the susceptibility of the patient. Prolonged screen examinations for renal calculus have sometimes produced burns for which damages have been claimed; but in the light of past experience such cases ought no longer to be possible. Neither ought the chronic "dermatitis of operators" ever to occur now that the necessity for suitable precautions is properly understood. But the cases that occurred (for instance, amongst hospital operators and others) before the danger was properly realised, still exist, and might constitute reasonable grounds for claim to compensation. Altogether it seems evident to those best able to form an opinion, that actions, to recover damages for X-ray burns caused by "diagnostic exposures" will become very uncommon in the future. But in view of the present extensive employment of "raying" for curative purposes, the question assumes a widely different aspect. Here repeated exposures are necessary, and no care and skill, however great, can at present guarantee an absolute immunity from risk. As is well known, ten to twenty days may elapse between the appearance of the deleterious effects and the exposure which caused them. Nature sometimes fails to hoist the danger signal until after the mischief is done. But apart from this the further question arises:—How far is a more or less pronounced dermatitis the usual and necessary accompaniment of cure?

It is evident that whoever undertakes the treatment of any morbid condition by X-rays, undertakes a serious responsibility. He must err neither on the side of rashness nor timidity. Especially must there be a complete understanding, perhaps even expressed in writing, that the patient is aware of the nature of the treatment, and is willing to accept its attendant risks or necessities. All this seems self-evident, yet a reference to the reports of cases that occasionally find their way into the Law Courts seem to show that these precautions are not always taken, and these responsibilities sometimes ignored. A case reported in the columns of this journal on May 20th, is instructive reading in this connection. Here a medical man sued the husband of the patient for payment of professional fees, and

the finding of the jury was to the effect that "the defendant did not consent to the X-ray treatment, and that the treatment was improper, negligent, and unskilful." In the face of the medical evidence, it is difficult to see how any other verdict could have been returned. If the treatment was applied without the knowledge and consent of the patient's husband, it was certainly, in this sense, improper. If it was deputed at one time to a layman, and at another to a nurse, it was certainly negligent, and this is a point by no means sufficiently insisted upon in the trial. That it was unskilful, seems to have been considered proved by the very extensive burning produced. Whether the medical evidence as to unskilfulness, and, indeed, other points would quite satisfy a critical observer, is, perhaps, another question. It seemed to be the impression of at least one witness that "if H.F. currents could do no good, they could do no harm." Such a view does not accord with the experiments of Bordier and Lecompte, who have demonstrated that such currents showing on d'Arsonval's instrument a milliamperage of about 500 can kill or paralyse small animals such as rabbits. Surely, therefore, high frequency currents must have some potentialities for mischief even in man. The same critic might even go further and demur to the very dogmatic utterances of some of these witnesses with reference to the inability of X-rays to penetrate beyond the skin and to influence internal disease. Again, in view of the fact that the "mechanism" of the X-ray burn has never yet been elucidated, the same observer might be surprised to learn that such burns can be "effectually prevented." Further, the same censorious person might refer to the fact that some operators think (and they have a right to their opinion) that a certain amount of dermatitis is the more or less necessary accompaniment of cure; he might even go bluntly to ask, in his own objectionable way, how far it is proper to tell a jury that every precaution ought to be taken to prevent such effects upon the skin.

Passing from the main issue certain reflections suggest themselves bearing on the whole question. In view of all that is known on the subject, has the medical employment of X-rays really reached that measure of scientific precision that might be expected? Knowing, as we do, how to sift and separate one from another the various radiations that proceed from an X-ray tube, why is there no record of exact experiments to ascertain what is the actually harmful agent —what the actually helpful one? Consider for a moment the chief components of this compound radiation :—Ultra-violet rays, alpha rays, cathode or beta rays, X or gamma rays. Of these it is known that the ultra-violet have but little penetrative power—a pocket handkerchief will stop them. With ease the alpha rays may also be intercepted. Much more difficult to arrest are the cathode and the X-rays, but here we have only to remember that the former can be deflected by a magnet and thus eliminated, leaving only the X-rays. But besides these radiations, there are also to be reckoned with certain chemical or oxidising effects, and also electrostatic effects. From the latter the skin can easily be protected by various devices, such as an earthed aluminium screen. The ionising, or oxidising, effect requiring, as it does, the presence of oxygen, might presumably be eliminated, as suggested by Sir Oliver Lodge, by employing an atmosphere of hydrogen, or applying a tightly fitting cover to the part, or in other ways.

It thus becomes evident that whatever be the deleterious or burning agent it can theoretically be eliminated. But again crops up the ever-recurring question—is this elimination desirable? Can we do without the effect in question? This chemical, or ionising, or oxidising action of the ray upon the air in contact with the tissues may be the cause of the burn, but there is, at least, an equal possibility that this very same chemical effect is the active agent in the destruction of the morbid growth. Such a hypothesis might help to explain the destructive effect of raying upon surface growths, its failure to influence the deeper tissues (which it certainly penetrates) being ascribable to the absence of oxygen; and those burning effects sometimes seen on the skin at the side most distant from the incidence of the rays might similarly be accounted for. Given the co-operating presence of oxygen, the X-ray might be able to influence even deep-seated tumours; and it is quite possible, as suggested by Sir Oliver Lodge, that, before long, we may find ourselves working on these lines.

What can be said of radium in this connection? Although the egregious claims and irresponsible statements that quickly followed on its first discovery have now, happily, given place to sober judgement and sound work, it cannot be said that much has hitherto been accomplished by the medical employment of radium. It is not exempt from the risks of the X-ray, but it certainly presents considerable facilities for application in certain difficult positions, and its gamma rays doubtless excel the X-ray in penetrating power. But then, again, as already insisted on, mere penetrating power is not all that is required; the X-ray has penetrated many a morbid growth, which, nevertheless, it has proved powerless to influence. Practical experience must be accumulated; we must be content to watch and wait and work with an open mind. But, in the meantime, unless it can be proved that radium can do something more than cure a rodent ulcer, it cannot claim superiority, or even equality in a comparison with the radiations of the focus tube.

The Conductometer. In the present issue is concluded an article by Mr. Rollo Appleyard under the above title, in which, besides dispelling some misapprehensions as to its scope and mode of operation, he further explains the theory and capabilities of the instrument. The conductometer is a striking example of the product of pure scientific reasoning applied with the specific purpose of attaining a definite end, whilst combining in the apparatus the utmost simplicity of construction and working with a sufficiently high degree of accuracy to fully comply with practical requirements. That Mr. Appleyard has succeeded to admiration in accomplishing his object, is best demonstrated by seeing the apparatus in use, as we have, and examining it in its latest form, which is before us; the only changes made in this type are in points of detail, improving the arrangement of the terminals so that mistakes in connections are practically impossible, providing a rack and pinion adjustment with no back-lash, and improving the arrangement of the two sliding scales. One of the most curious features of the instrument is the simplicity with which the necessary corrections are made—corrections which are unavoidable, no matter what system or apparatus is used, for they depend upon the wires under test—namely, in allowing for variations of cross-section. If the diameters of the wires are measured, the "deviation" per mil of difference from the standard, as measured, is simply $50 \div d$; if the wires are weighed, the deviation per unit of mass is given by $25 \div m$. These constants are absurdly simple to remember and use; but even they, of course, can be replaced by tables or curves. We believe that in the conductometer Mr. Appleyard has provided cable manufacturers with an instrument for workshop use which fulfils practical requirements to a degree beyond which nothing could reasonably be desired.

Prof. Rutherford on Radium. No man has done more than Prof. Rutherford to elucidate the nature of the processes going on in radio-active substances. His highly original and delicate experiments, and his masterly analysis of the evidence provided by these experiments, have revolutionised our ideas of molecular and atomic physics, and revealed to us the existence in matter of an unsuspected

source of energy. It is not to be wondered at, therefore, that his lecture at the Royal Institution on the 20th ult. attracted a crowded and brilliant audience. So great has been the public interest in radium, and so much has been published about it in technical and other journals, that it was difficult even for Prof. Rutherford to tell us anything new. The emanation from radium received special attention in the lecture. The lecturer stated that the emanation, though exceedingly minute in quantity, contained three-quarters of the whole energy of radium. If we could collect a cubic inch of the emanation, the tube which contained it would probably melt, while a few pounds of the emanation would supply enough energy to drive a ship across the Atlantic. The energy of the emanation does not last very long, since it falls to about half its original value in four days. Recent discoveries point to the conclusion that radium is widely distributed through the substance of the earth. The emanation has been found in the discharge of deep springs, in volcanic mud, and in clay soils in many parts of the earth's surface. This suggests the theory that the internal heat of the earth is due to radium, and if this be true it must lead to an important modification in the period calculated for the age of the earth by Lord Kelvin. Nothing could better illustrate the immense increase in the resources of scientific research than the rapid development of the apparently insignificant experiments of Becquerel into the present far-reaching theory of radio-activity.

Joint Electrical Supply Schemes.

THE recent inauguration of the Stalybridge, Hyde, Mossley, and Dukinfield joint electrical scheme marks an epoch in the development of municipal electrical undertakings in this country. This is, we believe, the first instance of a group of municipal authorities making common cause in a projected scheme of electricity supply, and the circumstances of its conception should prove of exceptional interest to those smaller authorities who have recently taken upon themselves, or propose in the near future to take over, the burdens and responsibilities of the electricity supply business. In fact, some such scheme as the above would seem to be the logical way out of the difficulties now fast approaching, which will beset the smaller municipal schemes when once the advantageous features of the many large power concerns are brought home to the consumer generally.

Before launching out into expensive extensions of small local plants, it would certainly appear to be worth the while of the smaller communities to ponder thoroughly some scheme for amalgamating their several interests in a larger and more comprehensive generating system. Such a step would, of course, involve the sinking of all petty local jealousies, which usually preclude common action on the part of neighbouring authorities. If these, unfortunately very real, difficulties could be overcome, and united interests be substituted for the present isolated ones, there would appear to be a reasonable prospect of successfully staving off the fateful day when bulk supply by the power company will either supersede or render unremunerative the smaller supply undertaking. It must, of course, be granted that the power company possesses inherent possibilities, denied, as things stand at present, to any municipal lighting concern.

However, there does not seem any solid reason why the attention so lavishly bestowed on "lamp" connections should not be transferred to the still, unfortunately, secondary motive power consumer. For despite the arguments of a certain plausible local paper, which candidly welcomes a proposed power company, because it may, by relieving the Corporation of its power consumers, help it over the voltage difficulties encountered in combined lighting and power supply, we cannot but regard the power consumer as the most important development at the present time, so important, in fact, that the power companies find it well worth their while to step in and cater for this demand specially. To the local Councillor who can realise the primary importance of the latter procedure and add to that, some appreciation of the value of united action among neighbouring authorities, we commend the Stalybridge example for what it may be worth.

THE REPULSION MOTOR.

By F. W. CARTER, M.A. Cantab.

(*Continued from page* 868.)

BEFORE entering on a mathematical analysis of the features of this motor, it might be well to mention some of its chief characteristics, since, although these will be fully brought out in the course of the analysis, the interpretation of mathematical results appears to be a rather rare accomplishment among engineers. The greater part of such interpretation, however, will be introduced in its natural place after the analysis, and the features here mentioned are service characteristics which might be observed in operating the motor.

As above mentioned, the motor possesses the drooping speed characteristic essential for a successful railway motor; that is, the terminal voltage being constant, the speed is low when the resisting torque is great, and rises continuously as the resistance diminishes. Synchronism is not a singular speed with this motor, which, in fact, is capable of passing through it, and running away like a continuous current series motor, if the counter-torque be sufficiently reduced. Whether or not the motor can be started from rest with full voltage on the terminals, depends entirely on what it has been designed to stand. With a given resisting torque the speed can be varied, as in the continuous current railway motor, by variation in the terminal voltage. With two motors, therefore, two speeds can be obtained corresponding respectively to series and parallel running, whilst it is possible to economically run at other speeds by the use of a compensator or auto-transformer. The speed can also be varied by shifting the brushes, being generally diminished as the short-circuited coil is moved farther from the centre of the field poles. Thus fractional speed running with this motor does not involve the waste of energy that attends the running of continuous current railway motors on resistance points.

An apparent objection to the repulsion motor lies in the fact that to reverse the direction of rotation it is necessary to shift the brushes with reference to the field from one side to the other of the pole centre, and, of course, the same objection applies to speed regulation by moving the coil under commutation. It would never do to have to actually shift the brushes of a railway motor, but in this case it is quite unnecessary, since it is easy to move the field pole. The stator winding will be a distributed one with all coils alike, and the position of the centre of the pole will depend on the connections between coils. If, therefore, the connections which control the above features are made in the reverser or controller, the pole can be brought to wherever we please. In the Latour and Winter-Eichberg modifications of the repulsion motor, the pole is shifted electrically to the required position; the auxiliary current introduced into the armature producing a cross field which, compounded with the main field, gives a suitably situated resultant.

We will here introduce the greater part of the analysis, leaving the interpretation of the results until we can take a comprehensive view of the whole.

Let figs. 1 and 2 represent the motor diagrammatically. Fig. 1 shows the electric circuits and connections, assuming a two-pole field, whilst fig. 2 is the corresponding working diagram referred to in the following analysis:—The reasoning will be so conducted as to apply to a multipolar motor, and where more than two poles are assumed, the armature, for the sake of definiteness, will be assumed multiple wound. This assumption is justified, since the action of the motor does not depend on convenience of winding. In fig. 2 let X^1OX be the line of the field poles, A^1OA the position of the coil short-circuited by the brushes, and P^1OP the position of any other armature coil. $AOX = \alpha$, $POX = \theta$. We shall assume the field and armature windings to be distributed as they would be in practice.

Let the applied or stator field at the armature face be assumed to follow a sine law both in time and distribution, and let its value at θ be $B \cos\theta \sin pt$ per unit angle.

The field due to the armature current has its maximum values at A and A^1, and is zero at right angles to these positions. Assuming the distribution of this flux to follow

a sine law also, let its value be, $-B^1 \cos \overline{\theta - a} \sin \overline{pt + \beta}$ at the armature face.

Armature Current.—The total flux of the applied field threading the coil P¹ O P is,

$$\int_{-\pi+\theta}^{\theta} B \cos\theta \sin pt \, d\theta = 2B \sin\theta \sin pt.$$

Hence the induced E.M.F. in this coil is,

$$-\frac{d}{dt}(2B \sin\theta \sin pt)$$

$$= -2B\{\omega \cos\theta \sin pt + p \sin\theta \cos pt\}$$

where $\omega = \frac{d\theta}{dt}$, the angular velocity of rotation of the armature.

To determine the total E.M.F. generated in the n coils forming one circuit between brushes, we take the mean

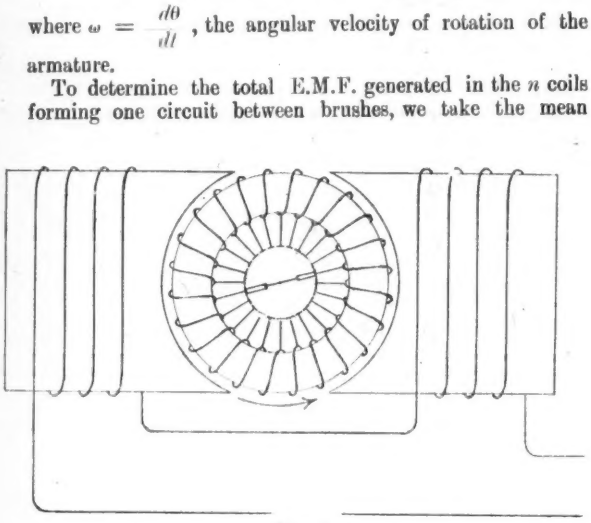


FIG. 1.

value of this elementary E.M.F. between the values $\theta = a$ and $\theta = a + \pi$, and multiply by n. Thus we get—

$$n \times \frac{1}{\pi}\int_a^{a+\pi}\{-2B(\omega \cos\theta \sin pt + p \sin\theta \cos pt)\, d\theta$$

$$= -\frac{4nB}{\pi}(-\omega \sin a \sin pt + p \cos a \cos pt).$$

Let L be the self-induction, and R the resistance of the armature, measured between brushes, and i the total armature current. Then—

$$L\frac{di}{dt} + Ri = -\frac{4nB}{\pi}(-\omega \sin a \sin pt + p \cos a \cos pt)$$

$$\therefore i = -\frac{4nB}{\pi}\sqrt{\frac{p^2\cos^2 a + \omega^2 \sin^2 a}{L^2p^2 + R^2}} \sin \overline{pt + \beta}, \quad (1)$$

where

$$\tan\beta = \frac{Rp\cos a + L\omega p \sin a}{Lp^2 \cos a - R\omega \sin a}. \quad (2)$$

β is, of course, the same epoch angle as was introduced in the expression $B^1 \cos \overline{\theta - a} \sin \overline{pt + \beta}$ for the armature current field, since this field is in phase with the current producing it.

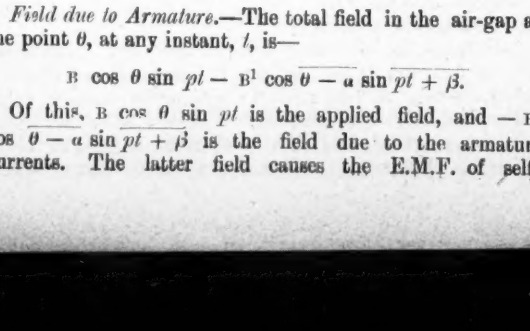


FIG. 2.

Field due to Armature.—The total field in the air-gap at the point θ, at any instant, t, is—

$$B \cos\theta \sin pt - B^1 \cos \overline{\theta - a} \sin \overline{pt + \beta}.$$

Of this, $B \cos\theta \sin pt$ is the applied field, and $-B^1 \cos \overline{\theta - a} \sin \overline{pt + \beta}$ is the field due to the armature currents. The latter field causes the E.M.F. of self-induction, so we can obtain the relation between B^1 and B by equating the E.M.F. caused by this field to the E.M.F. of self-induction. The flux due to the field in question through the coil at θ is—

$$\int_{-\pi+\theta}^{\theta}\{-B^1 \cos \overline{\theta - a} \sin \overline{pt + \beta}\}\, d\theta$$

$$= -2B^1 \sin \overline{\theta - a} \sin \overline{pt + \beta}.$$

The E.M.F. caused by this flux in the coil at θ is

$$+2B^1(\omega \cos \overline{\theta - a} \sin \overline{pt + \beta} + p \sin \overline{\theta - a} \cos \overline{pt + \beta}).$$

Hence the total E.M.F. of self-induction is

$$\frac{4nB^1}{\pi} p \cos \overline{pt + \beta} = -L\frac{di}{dt}$$

$$\therefore -Li = \frac{4nB^1}{\pi} \sin \overline{pt + \beta}.$$

Substituting for i from equation (1), we get

$$B^1 = BL\sqrt{\frac{p^2\cos^2 a + \omega^2 \sin^2 a}{L^2p^2 + R^2}} \quad (3)$$

— the relation required.

Torque.—The torque on the coil at θ is $2B \cos\theta \sin pt$ × current in the coil.

The torque on the n coils forming one circuit between brushes is—

$$\frac{n}{\pi} 2B \sin pt \int_a^{a+\pi} \cos\theta \, d\theta \times \text{current per circuit}$$

$$= -\frac{4nB}{\pi} \sin a \sin pt \times \text{current per circuit.}$$

Hence from equation (1), the torque on the whole armature at this instant is—

$$= \frac{16n^2B^2}{\pi^2}\sqrt{\frac{p^2\cos^2 a + \omega^2 \sin^2 a}{L^2p^2 + R^2}} \sin a \sin pt \sin \overline{pt + \beta}.$$

Thus the mean value of the total torque is—

$$T = \frac{8n^2B^2}{\pi^2}\sqrt{\frac{p^2\cos^2 a + \omega^2 \sin^2 a}{L^2p^2 + R^2}} \sin a \cos \beta$$

$$= \frac{8n^2B^2}{\pi^2} \frac{Lp^2 \cos a - R\omega \sin a}{L^2p^2 + R^2} \sin a. \quad (4)$$

(See equation 2)

We shall frequently use the abbreviation $\frac{R}{Lp} = q$. Substituting this in equation (4), we get—

$$T = \frac{8n^2B^2}{\pi^2 Lp} \frac{p\cos a - q\omega \sin a}{1 + q^2} \sin a. \quad (5)$$

(To be continued.)

THE CONDUCTOMETER.

By ROLLO APPLEYARD.

(Concluded from page 817.)

SINCE writing the foregoing account of the method of calculating the "deviation" for the *diameter* method, I have discovered a simpler and more accurate general expression for the scale-setting, which enables me to replace Curve I. by a surprisingly simple formula; for I can prove that *in whatever unit the diameter is measured*, the "deviation" for one such unit change in the nominal diameter is *50 divided by the diameter*. It matters not whether the diameter of a wire is expressed in mils, millimetres, or inches; if you choose *mils*, the "deviation" derived from the above formula will represent the number of scale-divisions of A A (fig. 1) to compensate for *1 mil* change from the nominal diameter; if you choose *millimetres*, the "deviation" will correct for *1 millimetre* change, and so on. For example, the "deviation" for a change of 1 mil in a 40-mil wire is simply $\frac{50}{40} = 1{\cdot}25$ divisions of scale A A (fig. 1, p. 816). The "deviation" to correct for a change of 1 millimetre in a wire of 80 mm. nominal diameter is $\frac{50}{80} = 0{\cdot}625$. More-

over, whatever the unit chosen for diameter measurements, the graduation of the conductometer remains the same, *i.e.*, each division of A A (fig. 1) is always $\frac{1}{100}$th of the total length of the bridge-wire; and the bridge-wire can be of any convenient length. The formula is therefore perfectly general. To obtain this formula we will begin with the general equation (5), p. 815, which may be written—

$$v = \frac{100\,dy + 50\,y^2}{2\,d^2 + 2\,dy + y^2}, \qquad (5)$$

where d is the nominal diameter of any wire expressed in any unit, and where y is a small change in that diameter, expressed in the same unit. In this equation, y may be given either a positive or a negative value. It is obviously not *strictly* correct to assume, as we have so far done, that the "deviation" for $+ y$ is exactly equal and opposite to the "deviation" for $- y$; for this is only rigorously true when y is infinitely small compared with d. To reduce errors, we might work with one or other of two expressions, according to whether y represents an increase or a decrease of diameter; but this would lead to complexity. The alternative is to calculate a *mean* value, applicable within close limits to either an increase or a decrease of diameter.

If we put $- y$ for $+ y$ in equation (5) we obtain—

$$v_a = \frac{-100\,dy + 50\,y^2}{2\,d^2 - 2\,dy + y^2}. \qquad (5A)$$

In arriving at a numerical mean from (5) and (5A) it is necessary to remember that the scale-setting v_a is opposite in direction to v. Before taking the mean we must, therefore, reverse the direction of v_a by multiplying the numerator of equation (5A) by $- 1$. The numerical mean is thus—

$$v_b = \tfrac{1}{2}\left(\frac{100\,dy + 50\,y^2}{2\,d^2 + 2\,dy + y^2} + \frac{100\,dy - 50\,y^2}{2\,d^2 - 2\,dy + y^2}\right).$$

This reduces to—

$$v_b = 25\,\frac{8\,d^3\,y}{4\,d^4 + y^4}. \qquad (5B)$$

Now since, by hypothesis, y is always small compared with d, we may with perfect assurance neglect y^4 in the denominator in comparison with $4\,d^4$. We thus obtain the useful form—

$$v_c = \frac{50\,y}{d}. \qquad (5C)$$

If y is unity, we have—

$$v = \frac{50}{d}, \qquad (5D)$$

i.e., the scale-setting for unit change of diameter in a wire whose nominal diameter is d such units, is simply *50 divided by the diameter*.

At the Physical Society last year I showed that the conductometer can be used with great facility for measurements by the *mass* method. A short statement of the method appears in the *Philosophical Magazine* for March, 1904. The theory is as follows: Let m_s, m_t be the masses of two wires of equal length and of equal percentage conductivities; and, as before, let L be the position of balance on a slide-wire divided into 100 equal parts. The condition of balance is—

$$\frac{100 - L}{m_s} = \frac{L}{m_t}$$

$$\therefore L = 100\,\frac{m_t}{m_s + m_t}. \qquad (7)$$

In obtaining equation (5) it was proved above that the scale-setting to compensate for differences, *i.e.*, the "deviation" is—

$$v = L - 50.$$

Hence, from (7), when the *mass* method is employed

$$v = 100\,\frac{m_t}{m_s + m_t} - 50,$$

or, numerically, expressed in scale-divisions,

$$v = 50\,\frac{m_t - m_s}{m_s + m_t}. \qquad (8)$$

Hence, the appropriate scale-setting is *fifty times the difference of the masses divided by the sum of the masses, for any equal lengths whatever of test-wire and standard wire, the masses being expressed in any single unit of mass whatever.* You can weigh your wire in tons or in milligrams, a yard of it or an earth-quadrant of it; from your weighings equation (8) will tell you through how many hundredths of the bridge-wire you must move the slider to compensate for the differences of *mass* of test-wire and standard wire.

Let us now suppose that we require to use the conductometer as a direct-reading instrument for the *mass* method. Equation (8) is so simple and so general that the "deviation" could be worked out in a few minutes, even by arithmetic. But even this arithmetic may be reduced. For, in equation (8), let—

$$m_t - m_s = 1.$$

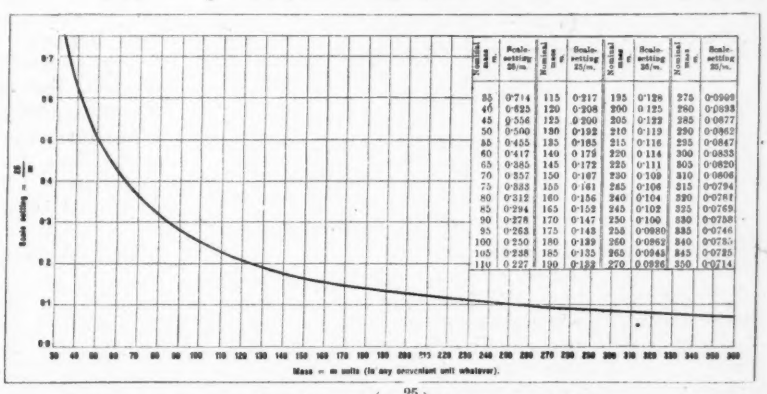
It then takes the form—

$$v = \frac{50}{2\,m_s + 1}. \qquad (9)$$

For all practical purposes, as will presently be proved, we can neglect the 1 in comparison with $2\,m_s$, so that the *mass* "deviation" may be obtained from—

$$v = \frac{25}{m_s}. \qquad (10)$$

Here v is the setting of the key K (fig. 1) in scale-divisions along the scale A A, *i.e.*, in hundredths of the length of the bridge-wire, corresponding to a change of 1 unit of weight in the nominal weight m_s, for any (equal) lengths whatever of standard-wire and test-wire, and for any unit of mass whatever. If each of the divisions on scale A A were divided into four parts, like scale B B, we should have merely to find the reciprocal of m_s from Barlow's Tables, and multiply it by 100; this would give us the "deviation" in quarter divisions of P P (fig. 1). But lest this device should be regarded as an unnecessary complication, some may prefer to draw a curve (curve 2)



Nominal mass m.	Scale-setting 25/m.	Nominal mass m.	Scale-setting 25/m.	Nominal mass m.	Scale-setting 25/m.	Nominal mass m.	Scale-setting 25/m.
35	0·714	115	0·217	195	0·128	275	0·0909
40	0·625	120	0·208	200	0·125	280	0·0893
45	0·556	125	0·200	205	0·122	285	0·0877
50	0·500	130	0·192	210	0·119	290	0·0862
55	0·455	135	0·185	215	0·116	295	0·0847
60	0·417	140	0·179	220	0·114	300	0·0833
65	0·385	145	0·172	225	0·111	305	0·0820
70	0·357	150	0·167	230	0·109	310	0·0806
75	0·333	155	0·161	235	0·106	315	0·0794
80	0·312	160	0·156	240	0·104	320	0·0781
85	0·294	165	0·152	245	0·102	325	0·0769
90	0·278	170	0·147	250	0·100	330	0·0758
95	0·263	175	0·143	255	0·0980	335	0·0746
100	0·250	180	0·139	260	0·0962	340	0·0735
105	0·238	185	0·135	265	0·0943	345	0·0725
110	0·227	190	0·132	270	0·0926	350	0·0714

CURVE II.—Showing the conductometer scale-setting $\left(= \frac{25}{m}\right)$ in hundredths of the length of a bridge-wire of any length or gauge, to compensate for a change by one unit of mass, for a wire of any given length, the nominal mass of that length of the wire being m such units.

from equation (9), by giving m_s successive values. This curve shows the "deviation" per unit of mass for any nominal *mass*.

From the form of the equations according to which the contact-slider is set with reference to the deviation-scale (A A, fig. 1), it is obvious that the degree of precision with which percentage conductivity can be measured by a conductometer depends upon the magnitude of the *difference* of of mass or diameter between a given length of a standard-wire and an equal length of a test-wire of the same *nominal* size. It is therefore necessary to investigate these limitations of the instrument. For convenience we will first estimate what is the greatest percentage change of *mass* that can safely be allowed with the conductometer. To determine this, we will go back to equation (8). Note that in this equation $(m_t - m_s)$ may have either a positive or a negative sign, according to whether the mass of a given length of the test-wire is greater or is less than the mass of an equal length of the standard wire. Now, the magnitude of $(m_t - m_s)$ must be so small in comparison with m_s that the conductivity as measured by the instrument shall be accurate within some prescribed limit, say within 0·1 per cent. As has already been proved, 0·1 per cent. conductivity is represented approximately by $\frac{0{\cdot}1}{4}$ hundreths of the length of the bridge-wire. Consequently, we must

not allow an error of "deviation" greater than $\frac{0{\cdot}1}{4}$ divisions of scale A A (fig. 1). To evaluate the magnitude of m_s to fulfil this condition let, in the first instance $(m_t - m_s) = 1$, then from equation (8)—

$$50\,\frac{m_t - m_s}{m_s + m_t} = \frac{50}{2\,m_s + 1} = \text{A}. \qquad (11)$$

Next, let $(m_t - m_s) = -1$, so that

$$50\,\frac{m_t - m_s}{m_s + m_t} = \frac{50}{2\,m_s - 1} = \text{B}. \qquad (12)$$

The "deviation" worked out from A is to agree with the "deviation" worked out from B to within $\frac{0{\cdot}1}{4}$. This condition is represented by the expression—

$$\text{B} - \text{A} = \frac{50}{2\,m_s - 1} - \frac{50}{2\,m_s + 1} = \frac{0{\cdot}1}{4}, \qquad (12\text{A})$$

which gives $m_s = 31{\cdot}6$.

Hence if we are to use *either* A *or* B, m_s must never be less than 31·6 of the mass-difference; or, in other words, we can only permit a 3·16 per cent. change of mass in m_s. But by taking the *mean* of A and B, we can obviously double this limit, making it 6·32 per cent. The mean is—

$$\frac{\text{A} + \text{B}}{2} = \frac{100\,m_s}{4\,m_s^2 - 1}. \qquad (13)$$

Now, in all cases where m_s is greater than 31·6, we may, without appreciable error, neglect 1 in the denominator of equation (13) in comparison with $4\,m^2$; hence equation (13) becomes simply equation (10), *i.e.*—

$$v = \frac{25}{m_s}.$$

When the degree of accuracy has been decided upon, it is useful to write equation (12A) in a more general form. Thus, if a is the percentage conductivity accuracy limit, replace 0·1 in equation (12A) by a; the equation then becomes—

$$a\,(4\,m^2 - 1) = 400.$$

Neglecting 1 in comparison with $4\,m^2$ we obtain—

$$m = \frac{10}{\sqrt{a}};$$

or, if the *mean* value is used, as above explained,

$$m = \frac{5}{\sqrt{a}}.$$

This gives us the safe limit of mass for unit change of *mass* for any percentage accuracy a.

We have next to estimate a similar limit for the *diameter* method, *i.e.*, we have to find how great a change can be allowed from the nominal diameter, so that the indications of the instrument may remain correct within a given percentage error of conductivity. Let b be the prescribed percentage error of conductivity which is permitted. In the same manner that we obtained equation (12A) from equation (8), we can from equation (5) write down the corresponding condition for the *diameter* method; here the difference between the "deviations" for an *increase* and a *decrease* of nominal diameter, by the amount y, is not to exceed $\frac{b}{4}$. This condition is—

$$\frac{100\,dy + 50\,y^2}{2\,d^2 + 2\,dy + y^2} - \frac{100\,dy - 50\,y^2}{2\,d^2 - 2\,dy + y^2} = \frac{b}{4},$$

which reduces to—

$$50\left(\frac{2\,y^4 - 4\,d^2\,y^2}{y^4 + 4\,d^4}\right) = \frac{b}{4}.$$

Or, approximately—

$$-\,50\,\frac{y^2}{d^2} = \frac{b}{4}. \qquad (14)$$

If $y = 1$, we have, numerically—

$$d = \frac{14{\cdot}14}{\sqrt{b}}. \qquad (14\text{A})$$

If instead of calculating the "deviation" from equation (5) or (5A) we use the *mean* value, as given by equation (5D) we double the precision limit, and we have consequently—

$$d = \frac{7{\cdot}07}{\sqrt{b}}.$$

For example, if $b = 0{\cdot}1$ per cent. conductivity, $d = \frac{7{\cdot}07}{0{\cdot}316} = 22{\cdot}4$. This means that we can allow a change of 1 unit in a nominal diameter of 22·4 such units, *i.e.*, a diameter change of 4·46 per cent., without introducing an instrument error greater than is represented by 0·1 per cent. conductivity.

By whatever instruments we measure electrical conductivity, the result obtained by the *diameter* method will not agree with the result obtained by the *mass* method, except within limits depending upon differences of density of the specimens.

In the ELECTRICAL REVIEW, Vol. 52, p. 1066, June 19th, 1903, I showed that since copper varies in density by about 0·05 above and 0·05 below the fair average density 8·9, it follows that when we transfer from conductivity determinations by the *diameter* method, to conductivity determinations by the *mass* method, the corresponding change due to density differences alone may be as great as 0·56 per cent. above or 0·56 per cent. below the value found by the *diameter* method. It is necessary to keep this in mind with *any* apparatus when checking the accuracy of an instrument by comparing its results when used for the *diameter* method, with those obtained with it by the *mass* method. The defect arises from the difficulty of transferring from "the resistance between the opposite faces of a centimetre cube" to "the resistance of a foot-grain;" such differences must be attributed to errors arising from definitions, and not to the particular measuring apparatus employed.

It is sometimes convenient in practice with the *mass* method to assume a standard density for copper of, say, 8·9, so that the masses can be calculated and standard resistance coils can be used with the conductometer. The resistance coils should be wound with copper wire, and care should be taken that such a standard coil, when in use, is as nearly as possible at the same mean temperature as the wire under test. Remember that the error is about 0·23 per cent. per 1° F. difference of temperature between the wires. If the temperature difference is known, it can be allowed for at once by setting the "conductivity scale" through an appropriate distance.

If by chance it happens that you have a standard resistance wire that exactly corresponds with a known per cent. conductivity for a given size of wire, and you have to test on the conductometer a batch of hanks a mil or so larger or smaller than that size, there is no need to go to the trouble of making a new standard wire. You have only to move the conductivity scale with respect to the electrical middle of the bridge through a distance corresponding to the appropriate "deviation," calculated as above described, and clamp it there. The conductometer is then direct-reading for the new size. The appropriate "deviation" is derived from the difference of the two nominal diameters, or nominal masses of the wires or the coils, exactly as if, in the ordinary way of using the instrument, one were the standard wire and the other the test-wire.

In the form in which the conductometer is now made by the India-Rubber, Gutta-Percha and Telegraph Works Co., Silvertown, the scale A A (fig. 1), carrying with it the key K, is moved by a rack and pinion, the rack being cut at an angle, so as to obviate back-lash. The mechanical details have been worked out for me very successfully by Mr. H. Berg, of the Silvertown Co. The bridge-wire S S (fig. 1) is two metres in length and is made of platinum-silver. As above explained, the greater part of this wire is wound upon two bobbins within the case of the instrument.

CONDUITS AND CONDENSATION.

[COMMUNICATED.]

FROM recent correspondence in the columns of the ELECTRICAL REVIEW, one might easily imagine that many people are doubtful of the value, and unaware of the properties, of the insulating lining in certain conduit systems. The writer of this little article hopes to clear up some of the doubt on this matter, and readers will probably agree with him that there are generally two sides to a controversy of this sort, and a correct solution lies somewhere midway between the two extremes.

As regards condensation troubles, the writer is inclined to believe that, whenever this occurs, it takes place chiefly on the outside of the tubing when a change of temperature, sufficient to cause a precipitation of "dew," has occurred between the surface of the conduit and the surrounding atmosphere. This condensed water trickles along the conduit, and succeeds, eventually, in getting into the joints to the interior, and finally comes to rest in some suitable bend, to the detriment of the cables or wires. Further, it tends to accumulate at such places, since the conditions for re-evaporation are poor in the extreme. If joints, then, were absolutely water-tight, it seems clear enough that such condensed water could not possibly gain entrance to the tubing, but absolute water-tightness seems difficult to obtain, unless a lead-covered system is used.

From the point of view of temperature change, iron seems the very worst material to use for conduits. Its very low thermal capacity, compared, say, with porcelain, and its relatively great conductivity for heat, render it a very easily-cooled substance. This occurs rapidly when it is placed in exposed or draughty situations, the quantity of air per day impinging on it, and depositing moisture, amounting to many thousands of cubic feet.

On a day, then, when a few degrees lowering of temperature causes the iron conduit to act as a condenser, it becomes important to examine the question of lining the conduit with a non-conducting substance; since it is clear that, owing to the small quantity of air inside the conduit, the heat stored in this way is insufficient in itself to keep up the temperature of the iron tube.

In this connection, it is interesting to compare the conduit to an engine cylinder subjected to a slowly cyclic periodic change of temperature.

For the flow of heat through an infinite plane slab, we have the equation—

$$\frac{\delta^2 v}{\delta x^2} = \frac{1}{k}\frac{\delta v}{\delta t},$$

and integrating this in the usual way, we have—

$$v = a\,\varepsilon^{-x\sqrt{\frac{\pi n}{k}}} \sin\left(2\pi n t - x\sqrt{\frac{\pi n}{k}}\right),$$

where v is the temperature at any depth, x is the substance, a is the amplitude, n is the frequency, and t the time. The symbol k is called the diffusivity, and for iron its value is 0·250, and for limestone 0·004. Regarding the maximum value of this fluctuation of temperature, viz:—

$$v = \frac{a}{\varepsilon^{x\sqrt{\frac{\pi n}{k}}}}.$$

We notice that a small value of k tends to reduce the amplitude. For instance, in the case of insulating material, the amplitude, after a time, is divided by ε^{16}; whereas in iron, in the same time, the amplitude is only divided by ε^2. We see, therefore, that the insulating material is not very subject to rapid fluctuation of temperature if its diffusivity equals that of limestone given above.

If, therefore, we regard the conduit as made up of an iron sheath which rapidly changes, or tends to change, its temperature, and lined with a non-conductor which has a store of heat to give out, it is clear the latter will tend to wipe out periodic changes as given above, by raising temperature, say $-\frac{x}{b}\theta$, where θ is the temperature of the non-conducting substance, and b the thickness of the iron sheath.

Hence, as in the case of the engine cylinder, we may at least use the above comparison as a guide. Since the insulating material, then, cools slower than iron, and owing to its stored heat, it tends to reduce temperature fluctuations. In other words, it acts as a kind of jacket giving up its store of heat to the iron sheathing.

In damp situations, this property may be very valuable, since, during the working hours, the insulating material will probably get heated, owing to the usual losses of energy in wires, some degrees above the atmospheric temperature of its surroundings. This will be given out slowly, tending to neutralise the cold, and consequent condensation, in the early mornings.

Further, there appears to be no reason to doubt that the lining prevents creeping of moisture along the internal surface of the tube from joints, &c., a matter of considerable importance where wiring of cellars, laundries, wash-houses, stables, &c., has to be carried out.

Cables have been known to stick in the conduit, necessitating cutting out pieces of tubing here and there, when a fault has arisen, and the insulating material has been blamed for this. However, the writer thinks this occurs when the *rubber solution* has been used as a lubricant in assisting the wires through a tight place.

When conduits are imbedded in *dry* mortar they are practically jacketed from all sudden thermal changes, and in this case the advantage of an insulating lining is discounted.

Further, it does not appear that there can be much condensation going on during the working hours of an installation. If the wires carry current at 1,000 amperes per square inch, or according to the Institution rule, viz.:—

$$C = A^{0.83} \times 2{\cdot}6,$$

there will be a rise of temperature of a few degrees above the surrounding air, especially in the larger sizes. This would probably be sufficient to check condensation under ordinary conditions.

On the whole, therefore, from this point of view, it appears to the writer that while lined conduits are desirable in certain circumstances, in the great majority of cases they are unnecessary.

Regarding the question of insulation, there is no doubt whatever that wood casing generally gives a higher result than ordinary conduit, and the writer considers this is due to the number of small junction boxes, &c., into which wires, and ends of cables, are cramped, and which allow considerable surfaces for leakage. Why it is that makers of electrical fittings persist in manufacturing switches, ceiling roses, &c., as small and cramped as possible, is probably one of those things which "no fellow can understand." It may be a relic of the telegraphic days of tapper keys, and, like the 4 ft. 8½ in. gauge, is likely to remain with us; but it seems obvious to any engineer that, for the sake of mechanical strength and better work in detail, a slight increase in the size of fittings mentioned above would be a step in the right direction.

There is no reason to doubt that the insulating linings of certain conduits do prevent leakage. If ρ = specific resistance of the insulating material, r_1 and r_2 its internal and external radii, and l its length, we have for the insulation resistance through the mass of material—

$$I = \frac{\rho}{2\pi l}\int_{r_1}^{r_2}\frac{dx}{x} = \frac{\rho}{2\pi l}\log_e\frac{r_2}{r_1}$$

or

$$I = \frac{0{\cdot}43\,\rho}{2\pi l}\log_{10}\frac{r_2}{r_1}.$$

It seems to the writer that this "extra bit" of resistance is of special value, since any flaws existing in the cable insulation due to any cause are not likely, when the cable is pulled into the conduit, to come near the possible one or two flaws existing in a length of conduit.

It appears to be a step in the right direction, as the ordinary method of covering wires with insulating material which, when subjected to a sharp knock or bend, is destroyed, seems mechanically, at least, absurd. However, house wiring has followed in the wake of the telegraphic, or deep-sea cable principles all along, otherwise we would probably have had quite a different system by this time.

Certainly anything tending towards a rigid insulation covering, and wires with less insulation, should be welcomed as a simplification.

It appears, therefore, that where very high insulation and freedom from moisture troubles are aimed at, the lined conduit is a *sine quâ non*.

Italy.—The municipal authorities of Modena have applied for a concession to erect a plant to utilise the water-power of the River Secchia for generating electrical energy for lighting and power purposes.

ELECTRICAL DEVELOPMENTS AT DELAGOA BAY.

There is no doubt that the Portuguese Authorities intend to use every endeavour to capture the trade of the Rand and the Transvaal generally, and for this purpose are going

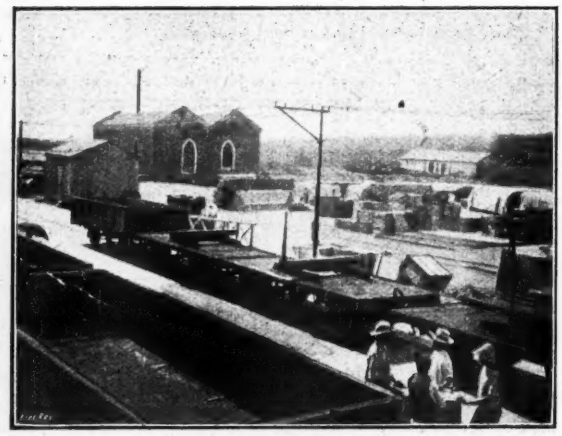


Fig. 1.—View of Power Station and Overhead Line, Delagoa Bay.

to considerable expense in bringing their wharves and harbour equipment "up to date."

They are now erecting six very large sheds for the storage of goods, and on the main wharf they have already installed four movable Temperley transporters supplied by Messrs. Arthur Koppel, Ltd. Two large Gantry cranes, one for a

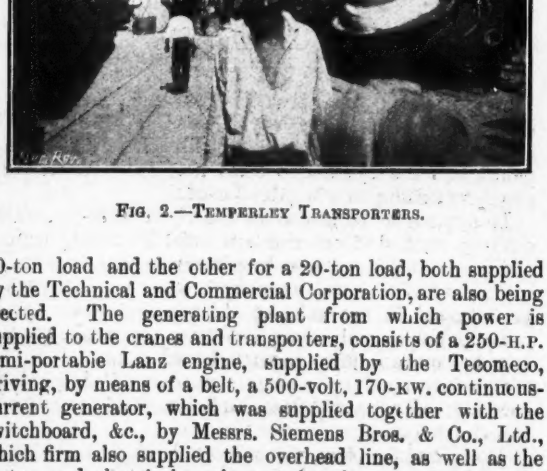


Fig. 2.—Temperley Transporters.

10-ton load and the other for a 20-ton load, both supplied by the Technical and Commercial Corporation, are also being erected. The generating plant from which power is supplied to the cranes and transporters, consists of a 250-H.P. semi-portable Lanz engine, supplied by the Tecomeco, driving, by means of a belt, a 500-volt, 170-KW. continuous-current generator, which was supplied together with the switchboard, &c., by Messrs. Siemens Bros. & Co., Ltd., which firm also supplied the overhead line, as well as the motors and electrical equipment for the cranes; the same plant is used in lighting the wharves and sheds.

There is a great deal of work in hand in connection with these wharves, including considerable extensions of the wharves themselves and deepening of the harbour in their vicinity, also duplication of the power plant, the installation of five or six more electric cranes, and various other apparatus intended to bring the whole equipment completely up to date. Fig. 2 shows the four Temperley transporters; fig. 3 the 10-ton crane which is being used in the erection of the 20-ton crane; and fig. 1 shows the overhead lines with the power station in the distance.

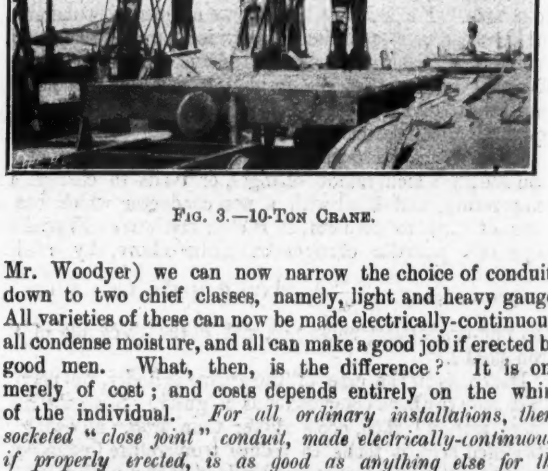


Fig. 3.—10-Ton Crane.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Recent Developments in Metal Conduit for Electric Light Installations.

As I believe that all the makers of conduits have now taken the opportunity of telling us that their own system is the only infallible one, may I, who am neither a maker nor one interested in any particular system, add a few words to this correspondence.

As to which system is the best, it appears to me that the answer to this question depends entirely on the point of view from which it is approached.

There are so many conditions to be filled that it is impossible to lay down any rigid rule, and this is the reason why makers have put so large a variety of conduits on the market. But there are at least two points that cannot now be ignored, no matter what system is used. These are (1) electrical continuity, and (2) the employment of good fittings. Most of those who have joined in this correspondence have, in their anxiety to push their own wares, lost sight of the point of Mr. Waterhouse's article, namely, that by the use of a certain novel device, "close joint" conduit can be made electrically continuous; and so where the expense of screwed conduit (be it brazed, wireduct, armorduct or any other fancy name) is prohibitive, its chief advantage can be secured at merely nominal cost. After all, this improvement is a great step forward; and as condensation is a disease common to all conduits without exception (*pace* Mr. Woodyer) we can now narrow the choice of conduits down to two chief classes, namely, light and heavy gauge. All varieties of these can now be made electrically-continuous, all condense moisture, and all can make a good job if erected by good men. What, then, is the difference? It is one merely of cost; and costs depends entirely on the whim of the individual. *For all ordinary installations, then, socketed "close joint" conduit, made electrically-continuous, if properly erected, is as good as anything else for the life of rubber-insulated cable,* unless the installation be deliberately attacked with sledge-hammers and picks. Therefore, the startling announcement made by your correspondent, Mr. Gunner, that improvements in the process of manufacture of screwed brazed conduit now enable it to be produced at an equal price to either wireduct or armorduct, is of little interest. If great strength be required either of these conduits will be used; if this factor can be

ignored (as I maintain it can) then electrically continuous "close joint" conduit is good enough for all ordinary purposes (I purposely exclude mines, chemical works, &c.).

Turning now to the question of fittings—and as one who knows what he is talking about, I must express surprise at the statements put forward by Mr. Gunner under this heading—I can only think that his "connection with the trade" must have been somewhat limited, and cannot have included practical experience in erecting. He is evidently young and enthusiastic, but has much to learn, particularly that the *selling* of conduit does not conduce to mature judgement on questions of its *erection*.

If there is one thing detrimental to any installation of conduit it is the use of cheap fittings. It is all very well to speak of improved processes of their manufacture which enables the cost to be reduced, but this is a catalogue expression as old as the hills, and generally means that an attempt is to be made to cut prices at the expense of quality. It also assumes that one's competitors are not as alive to up-to-date methods of manufacture as one's own firm, a somewhat rash deduction usually prompted by false perspective.

The contractor cannot be sufficiently warned about his choice of fittings, for it is in these where faults, if any, will develop owing to sharp corners, burrs, and ridges; this is especially the case with elbows, bends, and tees. It may be true that "the dearest is not necessarily the best," but any man of sound judgement knows that if he wants to buy a good thing he must pay a good price, and that only by acting on this rule will he in the end obtain true satisfaction.

Tertium Quid.

After the letters of Messrs. Isherwood and Schmahl, pointing out Mr. Bathurst's published opinions, and the position he took up relative to plain and lined conduits, I had expected that ordinary courtesy would have prompted Mr. Woodyer to withdraw his expression that I had made use of misleading statements with reference to Mr. Bathurst's position in this matter.

To make my contention perfectly clear, and at the risk of repetition, I will refer to my original statement:—"It would be some satisfaction to those who had devoted their attention to ordinary conduit to know that, shortly before his death, he (Mr. Bathurst) severed his connection with lined conduits, and devoted his attention to perfecting a system of plain tubes."

Mr. Woodyer asks, Would not this lead anyone to infer that Mr. Bathurst changed his opinion in favour of unlined conduits? Possibly it would do so, and Mr. Schmahl's extract from Mr. Bathurst's paper on "Electric Wiring Methods of To-day," published in the Electrical Review of April 11th, 1902, clearly shows that he had done so; otherwise, he would not have stated—"an insulated conduit is not only unnecessary, but is an obstacle in the way of the development of conduit wiring."

These are precisely my own views, and if the above recital does not induce Mr. Woodyer to withdraw his statement, I can only place him in the same category as the woman convinced against her will, who, we are told, remained of the same opinion still.

My opposition to lined, or so-called insulated conduits is not due to the fact that they are inferior in any way to other metal conduits, but I object to the heavy prime cost of the material, and to paying for a lining which serves little or no useful purpose, while, on the other hand, it reduces the capacity of the conduit, and generally tends to increase wiring costs.

The way in which Mr. Woodyer sails round my questions, and asks himself others more suitable for reply, is amusing, though scarcely instructive. With reference to comparative costs, although Mr. Woodyer did not answer my questions, the information can be easily obtained by anyone sufficiently interested to inquire into the matter. From data I have in my possession it appears that a lined tube installation costs in erection per point, anything between three and five times as much as an equivalent unlined system.

In connection with the absorption of moisture by the lining of these tubes, I think Mr. Woodyer is somewhat out of his depth in his reply, but rather than give my own figures of tests of this material, I would ask anyone interested to obtain a sample of this lining and to cut away the tube and test for absorption after 24 hours' immersion. The result will by no means confirm Mr. Woodyer's assertion that the material employed is equal to hard rubber. I shall be surprised if they do not find discolouration of the water by the ingredients used to impregnate the paper, coupled with a certain amount of deposit, and after removing surface moisture from the lining, an increase in its weight of from 10 to 20 per cent.

"Steel conduits are seldom laid in water"—possibly not, but, unfortunately, we cannot get away from condensation, and Mr. Woodyer has now to qualify his previous statement by remarking that the lining prevents "appreciable condensation."

In my own experience I have seen little to distinguish in the amount of condensation in lined and unlined systems, and if the lining is absorbent its presence is not only unnecessary but detrimental from every point of view.

Towards the conclusion of this letter, I find one statement in which I am of the same opinion as Mr. Woodyer, viz., "there are plenty of situations favourable to unlined conduit wiring where the cost of other systems is prohibitive." I notice, however, that for these installations he advocates solid drawn tubes.

I venture to suggest that it is not so much what Mr. Mr. Woodyer advocates, but what the contractors order, that is material. For the majority of installations a very much cheaper conduit would be all that is required, and Mr. Woodyer allows that "there is a large field for cheap tubes," which field he leaves to others. For this, at least, one must be grateful to him.

Although indebted to Mr. Schmahl for giving the reference to Mr. Bathurst's published opinion previously referred to, which substantiates my former remarks, notwithstanding the exception taken by Mr. Woodyer, I regret I cannot agree with all the points raised in his letter.

Firstly, with regard to "Wireduct," I think I may safely say that this was brought out before "Armorduct" had created a demand, the reason for its appearance being due to the fact that there was a call for a cheaper quality of material than the heavy gauge screwed brazed.

In connection with the screwing of brazed conduits, I cannot agree that there is any difficulty. In fact, owing to the uniformity of their gauge and diameter, the operation of screwing is greatly simplified; and I do not think Mr. Schmahl's contention that the larger percentage of screwed conduit now being used is welded or solid drawn is borne out by fact. All three grades of material are largely supplied by the Simplex Steel Conduit Co., Ltd. I can therefore speak with authority on the point. No welded tubing, as far as I am aware, can be made with the evenness and accuracy of rolled brazed tube, nor can the interior of a welded tube be guaranteed so free from internal obstruction.

In comparing various descriptions of metal conduit, Mr. Schmahl can easily see from reference to my original article that I mention three distinct requirements, and I quite agree that cost enters very considerably into the comparison of each of these—I should not, for example, think of comparing Simplex ordinary tubing with the higher class Simplex solid drawn.

So far as earthing devices are concerned, I agree that in general these have not hitherto proved satisfactory. This question is one in which the company I am connected with has spent a good deal of time and money in developing, and although over two years ago we had taken out a number of provisional protections, it is only quite recently we have perfected an idea which is both reliable and cheap, and in which we have sufficient confidence to place it before the public.

Although Mr. Schmahl has no great opinion of earthing devices, and is unable to recognise anything between a proper screwed conduit system and a socket joint one, I hope shortly to show him that with the "Simplex" continuity system all the advantages of a screwed tubing can be secured at a lower cost both for material and labour.

The absence of all screwing tools on such a job makes so considerable a difference in the labour charges and time occupied in erection, that contractors who are in a position to appreciate what such a saving means, will doubtless be the first to show their appreciation of the Simplex continuity system.

L. M. Waterhouse.

May 31st, 1904.

[This correspondence is now closed.—Eds. E.R.]

Disputed Results from a Refuse Destructor.

Having read the two letters under the above heading published in your last issue, I think a few facts will easily explain matters, but as Messrs. Meldrum Bros. promise further information, I am of opinion that it will be better to wait for these and reply in one letter.

R. Birkett.

Burnley Electricity Works,
May 31*st*, 1904.

The Price and Quality of Rubber.

With reference to the article in your last issue anent the high price of pure rubber on account of its continued growing scarcity, it may interest your readers to know that a scheme has been already in course of profitable development now for some years by which the demand for this article is being met by the planting of immense rubber orchards in a part of the American Continent eminently adapted to the purpose. One of these orchards comprises 6,175 acres, and is situated in the State of Chiapas, Mexico, and this is being planted with as great a speed as is rendered possible.

As is well known to many, the present difficulty of obtaining rubber is due to the barbaric treatment to which trees in the past have been subjected by the natives in mercilessly tapping to death the trees of the virgin forests, and not infrequently felling them in order to get all the exuding juice. These natives have been totally incapable of providing for future supplies, and hence the present scarcity. The following figures, taken from the *India-Rubber World*, published in New York, will give an idea as to the rapid increase of price per lb. of crude rubber during the 10 years ending 1900 :—

	s.	d.		s.	d.		s.	d.		s.	d.
1891 ...	2	6	to	3	11½	1896 ...	2	11½	to	3	6½
1892 ...	2	7	to	3	1	1897 ...	3	3½	to	3	8½
1893 ...	2	8	to	3	3½	1898 ...	3	5	to	4	5
1894 ...	2	8	to	3	0½	1899 ...	3	9½	to	4	7
1895 ...	2	11	to	3	4½	1900 ...	3	5½	to	4	7½

The scheme under development at once appeals to those directly interested in the supply of crude rubber for manufacturing purposes, as the uses to which rubber is put are increasing at an enormous rate, and also to others in other ways.

I shall personally be very pleased to give what information I can of this scheme to any one interested.

Wm. P. Mendham.

Bristol.

Tramway Management.

I very much regret to notice Mr. W. R. Bowker's letter in your current number, couched in so fearful a strain, calling upon tramway managers everywhere to tremble and quake for the terrible times that are coming upon them.

I would suggest that the most effectual way to prevent such calamities as he fears, is for all managers and authorities to make up their minds as to the best wages and conditions of service they can afford to offer their employés, having regard to the prosperity of their undertaking, and having decided upon these, to see that the places of those employés who are not prepared to accept them without grumbling and banding themselves into offensive and defiant organizations, are filled by new men who *are* satisfied with the wages and conditions offered.

As one who has had considerable experience in tramway strikes, I can assure Mr. Bowker and other fearful ones that the filling of vacancies with competent drivers and conductors does not present the difficulties he imagines to any determined and capable management.

Assistant Manager.

Municipal Appointments.

You have recently had some correspondence in reference to the above; perhaps the experience of an officer in one of the boroughs within the Metropolitan area would be of interest to those who contemplate seeking a post at some future date in a borough where the Labour Party is in office. Recently this officer had reason to complain to some of "his" men as to the lazy way they were working, and instead of the said men being dismissed, they immediately, under the protection of their various unions, sent a deputation to various Committees, and to the full Council, making countercharges against this officer as to the manner in which various schemes were carried out, and further charges of a personal character. Now, what is the position of this officer?—His authority is *nil*, and if his department does not pay he is censured and threatened by the Council, and he cannot weed out the bad workmen, but has to attempt to run with excessive wages and bad workmen, who are under the control of several domineering unions.

These officers are at the mercy of the same unions who not only control the men, but the full Council, and it is time, I think, that officers formed for themselves a similar union for their protection. The Institution instead of doing anything in the interests of station engineers, a body to whom it owes the greater part of its income, lends itself to the self-interested discussions of various manufacturers.

Desperandum.

Street Lighting by Nernst Lamps.

Your correspondents, "Two Shift Engineers," in their criticism in your issue of the 20th ult. of my article under the above heading, very wisely state that the cost of current is "the crux of the whole question," and their answer to the question, "Can I dump current at ¾d. per unit?" is an emphatic negative. In support of their assertion they cite Folkestone, which they find in the tables of costs compiled by a contemporary is debited with 1·21d. per unit for coal, water, oil, waste, and stores.

A question of this nature can hardly be solved by reference to the figures of a single station, badly situated as it is for cheap fuel. Prompted by your correspondents, I have therefore taken an average of the figures published in the tables referred to, with the following results:—Average of 161 local authorities (for coal, water, oil, waste and stores) ·776d. per unit. Average of 56 companies ·909d. per unit; or, taken together, an average for 217 undertakings of ·81d. per unit. My estimate of ¾d. per unit was therefore not very far wrong, and if I had taken ·81d. instead it would not have greatly affected the result.

Your correspondents take exception to the omission of other charges, as well as profit, in my summary, but in doing so they miss the whole point of the article, in which I endeavoured to compare the mean cost of gas lighting in different towns under the same conditions, with that of electric lighting under similar conditions.

I found that gas lighting worked out at £3 12s. 6d. per lamp per annum, and electric lighting under one set of conditions at £2 8s. 6d., and under another set of conditions at £2 16s. 6d. Had I taken the generating cost of a unit at ·81d. instead of ·75d., these figures would have been £2 10s. 7d., and £2 18s. 7d. instead. Deducting these from £3 12s. 6d., we have £1 1s. 11d. and 13s. 11d. respectively, which represents a margin for competition and profit.

I do not, of course, suggest that if £2 10s. 7d. be the cost price of electric lighting, and £3 12s. 6d. the price at present paid for gas lighting, the former figure would be quoted in competition with the latter, but I do suggest that some mean figure, say, £3, if coupled with a guarantee of better illumination, might be low enough to undercut the gas company, and yet high enough to earn a reasonable profit.

I think "Two Shift Engineers," in the overheated atmosphere of their engine room, are a little "fuddled" by the word "dumping." I would suggest the popular tin plate analogy. If it costs £200 to install a press, and an engine or motor to drive it, and after taking off, say, 50,000 tin plates at 2d. each, the plant and all attendant costs have been paid for and a profit earned, then the manufacturer is justified in competing for the sale of a further quantity of plates in a market where he cannot expect to get more than ¼d. each for them, provided the bare cost of production is something less than that figure; and in estimating this cost price he has no longer to consider the capital cost of his plant, but only the material, labour, and cost of power.

To carry the analogy a step further, let the twopenny article be one that is stamped out so as to leave a central blank, which, with an alteration of the dies, can be pressed

into a farthing article simultaneously with the production of the twopenny one. Then if in the sale price of the latter allowance has been made for the original plant, the former need only be debited with the scrap value of the blank, the capital cost of the alteration to the dies, and a fraction of the total driving power, and no charge need be made for labour, &c.

Is not street lighting a similar case? It is a steady load on boilers already under steam, and may be treated as a valuable by-product. It will not fetch the normal market value of electricity, but it may be possible to sell the requisite units at a price which will allow a small margin for profit after allowance has been made for the extra capital expended and the cost of generating the extra units. Why not try to get it on such terms, if it cannot be obtained on any better?

Your correspondents raise other points, such as the cleaning of globes. This item does not affect the costs, as an electric light globe does not require frequent cleaning, like the lantern of a gas lamp. If it is wiped out with a cloth every time a burner is renewed, it is all that is required in practice. It would be frivolous to make any charge for this. The breakdown of Nernst lamp mechanisms is also mentioned, but I think sufficient allowance has been made for this under the heading of repairs and maintenance.

In conclusion, while thanking "Two Shift Engineers" for their friendly criticism, I would point out to them that I have never advocated giving current away; and I would express my humble opinion that the day which they hope for when "gas lighting in our streets will be practically unknown," will only be brought to pass by a general recognition of a public lighting load as a by-product, and street lanterns as a "dumping ground" for surplus electricity.

Henry Joseph.

Hythe, *May* 31*st*, 1904.

["Economic" Lamps.—Will the correspondent who asked a question respecting these lamps send his name and address to the Editors; they have been mislaid.—Eds. E.R.]

REVIEWS.

The Fundamental Phenomena and Principal Applications of Alternating Currents. By R. Swyngedauw, Professor of Electrotechics at the University of Lille. Paris: Vve. Ch. Dunod. 1904.

This book is written, so says the preface, especially for readers who are already conversant with the principles of continuous currents, and who desire to become acquainted with the fundamental phenomena and principal applications of alternating currents without wading through special and too voluminous treatises.

Although a knowledge of continuous currents is supposed to be assumed, the author unaccountably devotes four out of 19 chapters to principles which every student acquainted with continuous currents can take as read—Ohm's law to wit, and other elementary principles of like simplicity.

The author pre-supposes that his readers possess such mathematical knowledge as includes familiarity with simple differentiations and integrations; in fact, there appears to be an unnecessary fondness for the sign of integration, as it frequently occurs where simple algebra or trigonometry would have been far more effective.

It is true that the author has excluded from the book everything which could be termed advanced either in theory or practice, but it is our experience that most people who wish to study alternating currents fight shy of an integration, and jump to the conclusion that it is only used to prove problems which are beyond their comprehension.

The book contains nothing new, nor does it contain even the latest information on the subject. It does, however, state fairly clearly the rudiments of both practice and theory.

It may be that on the Continent students and engineers receive a better mathematical training than—it is humiliating to suggest it—they do in England. If so they will find the book very useful, but the ordinary English engineer would do better to purchase an English treatise couched in really elementary mathematical language.

We have often deplored the want of theoretical training which the majority of our really good practical engineers possess, but the present treatise is not, so far as this country is concerned, likely to prove any incentive to inquire further into the subject of alternating currents.

The printing and the diagrams do the publisher credit, but, unfortunately, the text does not appeal to us from a popular standpoint, and since the book is avowedly written for the multitude, we cannot honestly say that it has fulfilled its purpose.

The Phase Rule and its Applications. By Alex. Findlay, M.A., Ph.D., D.Sc. Together with an introduction to the study of Physical Chemistry by Sir William Ramsay, K.C.B., F.R.S. London: Longmans, Green & Co. 1904. Price 5*s*.

This book is the first of a series of seven distinct volumes, which, when complete, will form a text-book of physical chemistry. It also contains a general sketch of the whole subject, written by Sir William Ramsay, who is editor of the series. Not so very long ago, organic chemists were carrying things with rather a high hand, and went so far as to whisper that the inorganic branch was worked out. A reaction followed, due, in a large measure, to the researches of Van't Hoff, Ostwald, Arrhenius, and others, and the place which, at one time, it was hoped that thermo-chemistry would occupy, has been, to a large extent, filled by electrolysis. This has caused a new crop of inorganic text-books to appear, far more valuable to the student than their predecessors; but that crop, planted and watered on Continental or American soil, has chiefly given its increase in our country in the shape of translations. Now, however, we are about to have offered us a comprehensive treatment of theoretical chemistry from the physical side by British masters and specialists, and in consequence we shall be freed from the linguistic curiosities of current American scientific phraseology, as well as from the very natural tendency of all writers to exalt the work done by their compatriots.

As has already been indicated, the volume before us is really two works bound together. The first brings the theoretical side of chemistry, from the days of the four elements, up to the present time, and shows the bearings upon the whole science of the particular subjects which are to be treated in detail in this and succeeding volumes. It is no exaggeration to say that Sir William Ramsay has given us an extraordinarily luminous introduction, which, though highly (too highly?) condensed, touches upon everything of importance, and yet is very pleasant to read by reason of its simplicity and perfect balance. Sir William rounds off his essay (which is also to be obtained separately) by a reference to thermodynamics, mentioning the supersession of Berthelot's and Thomsen's law of dissipation of energy in chemical change by that which announces the greatest stability of a system in which entropy is at a maximum. This leaves the ground clear for Dr. Findlay's treatise on the phase rule.

The phase rule, put forward by Willard Gibbs, of Yale, who died just a year ago, and rendered more pliable and useful by Roozeboom, is a generalisation which enables chemical equilibrium to be understood, and in many cases permits of prophecy as to the changes which will take place under given conditions. It is not complete in itself, requiring certain numerical data to be known; but when this is the case, the phase rule is an indispensable instrument in careful and experienced hands. To give the simplest example of what the phase rule teaches, we may take water. Ice (normal ice) is permanent in air below a certain temperature, melting at a point governed by the pressure. Water vapour is similarly permanent above a certain temperature which depends on the pressure. Between these points (neglecting "lag," and meta-stable equilibrium) liquid water is the stable form of H_2O. Thus, within limits, ice alone, water alone, or vapour alone, can exist at any temperature and at any pressure. But mixtures of ice and water—or any two of the so-called "phases" of the "component" or "substance" H_2O—can only exist side by side at one temperature, which depends on the pressure prevailing, or at one pressure which is governed by the temperature. And a mixture of ice, liquid water, and water vapour can only co-exist at one fixed temperature and at one fixed pressure, whatever quantity of each phase may be present. Hence a system of one component in one phase is "bivariant," of one component in two phases is "uni-

variant," and of one component in three phases is "invariant."

But since we know the melting points of ice and the boiling points of water at different pressures, and the vapour pressure of aqueous vapour at different temperatures, the phase rule enables us to calculate the "triple point" of the invariant system ice-water-vapour, to draw the curve of any univariant system, or to delimit the field of a bivariant system. Somewhat similar rules apply where more than one component is present, and where the number of phases is other than three. Alloys can be studied most usefully by the light of the phase rule, even those complicated materials which compose "iron" and "steel." In fact, expressed symbolically, the phase rule is:—$P + F = C + 2$, where C and P are the components and phases, and F the "degrees of freedom" or of variability in the system.

Dr. Findlay's book strikes us as a very lucid exposition of a somewhat involved subject, and as he treats it with the aid of numerous examples, the argument is easy to follow. It is a handy little volume, not too heavy to hold, and we need hardly say that it is excellently printed and bound.

Rubber, Gutta-Percha and Balata. By Franz Clouth. First English Translation, with Additions and Emendations by the Author. London: Maclaren & Sons. Price 12s. net.

Herr Franz Clouth, the author of this work, is a well-known rubber manufacturer in Cologne. His first contribution to rubber literature dates back to 1873. Another book followed in 1879, and the German edition of the present volume was published in 1898. Comparing that with the book under review, it is manifest that a considerable portion of it has been re-written, a few chapters added, and almost the whole of it brought up to date.

The author modestly disclaims any attempt to teach his brother manufacturers how to manufacture rubber goods. Consequently the volume must be judged on its merits as a popular exposition of the rubber industry. Herr Clouth's experience has enabled him to steer clear of unnecessary details, and to place before the reader a clear and extremely readable account of how the crude material is collected, prepared, and manufactured. By a system of systematic condensation and tabulation in portions of the book he has managed to do more than that, for the more ambitious student of the volume can become acquainted with such details as the casual reader may skim over.

From a rubber manufacturer's point of view, there is much that is useful in this work. From an electrician's standpoint, a more useful book could hardly be desired. It is true that the application of rubber and gutta-percha to the electrical industry is only briefly touched upon, yet this is of little account, since up to its last stage, the manufacture is practically the same as for all other classes of goods. Considering the great importance of rubber and gutta-percha in the electrical industry, it is curious how little knowledge of them the great majority of those engaged in it have. Even from a purely commercial standpoint, a better understanding of the material would bring good results. We do not suggest that every reader should become an expert in rubber, and that he should have a knowledge of every one of the 78 sorts of rubber (which the author gives details of, and which are on the market), but we certainly think he would be the better for knowing a little about these, rather than be content, as at present, with the vague knowledge that rubber is extracted from the milk of a tree, and that the very finest kind is called Para. From a commercial standpoint, also, the record of prices of Para rubber from 1861 to 1903 (given in chart form), will show him how impossible it is to use Para rubber at these prices, and produce insulated wire at the absurd price he is in the habit of offering for it.

From the technical point of view, it is also well that he should understand what vulcanisation means, what processes the rubber has to go through, what the ingredients in a mixing generally are, why they are used, and what are the results. An insulated wire manufacturer does not mix his rubber with a certain percentage of mineral matter because it improves its insulation properties, but in order to cheapen the mixing. He cheapens the mixing because of the pressure brought to bear on him by his customer. Those who remember rubber insulation as it was, and what it has generally come to now, will appreciate the author's protest against this harmful practice of trying to buy too cheaply.

An interesting historical chapter opens the volume, followed by a chapter on the natural history of the rubber trees, which the general reader, unless he be a botanist, may safely pass, with the exception of the names of the half-dozen trees which are the principal sources of rubber. An excellent in-folded map of the rubber-producing districts of the world is worth study. The chapter on the Production of Raw Rubber is excellently done, and the details of the processes in general use are fully given. Next follows a chapter on the Commercial Points of the raw rubber, a vast amount of information being given, in well-arranged tabular form, relating to all the rubbers on the market, their origin, impurities, and description.

Following an interesting chapter on the chemical and physical properties of india-rubber comes a description of the manufacture of soft rubber goods (*i.e.*, articles of rubber other than ebonite), in which the various processes and general procedure are clearly explained. The important process of vulcanisation is given a chapter to itself, and merits special attention from the reader, as without a full knowledge of this and its results, the change in the properties of rubber from the crude to the manufactured condition cannot be understood. The chemical and physical properties of the now vulcanised material are detailed, as well as the best conditions for storage, &c. A similar, though shorter, description of the manufacture of hard rubber or ebonite is then given, followed by an interesting chapter on the use and abuse of reclaimed rubber and substitutes.

A precisely similar method is followed in describing the history, collection, qualities, production, and properties of gutta-percha and balata, the latter, however, being more briefly treated. Through the book a considerable number of illustrations are given, botanical and mechanical, as well as a couple of maps and the price chart already alluded to.

Viewing the book as a whole, it is apparent that while as a complete guide to the manufacturer of rubber and gutta-percha it lacks many necessary details, yet as a clearly written and intelligent account of rubber and gutta-percha manufacture it is a valuable work for those engaged in the electrical industries, to whom a little more knowledge on this subject than they now possess would by no means be a dangerous thing.

Compte Rendu du Congrès de la Houille Blanche, 1902. Grenoble: Syndicat des Forces Hydrauliques. Price 30 fr. net.

The Committee of the Congress of the "Houille Blanche," and the Administrative Council of the Syndicat des Forces Hydrauliques have recorded the proceedings of the Congress which was held last September at Grenoble, Annecy, and Chamonix, and of the visits paid to installations in the adjoining districts, in a most thorough and even sumptuous manner. It was pointed out, in the circular convening the Congress, that it was at Grenoble, in 1883, that Marcel Deprez carried out his famous experiments; since then enormous progress had been made in the utilisation of natural sources of power by means of electricity.

The first volume contains the detailed report of the business meetings of the Congress, followed by papers contributed to the proceedings by the members. While the domestic affairs dealt with are of little interest to foreigners, the papers, on the other hand, are of value to all who have to deal with water-powers, and the allied subjects of climatology, hydrology, and meteorology as bearing upon the utilisation of natural falls of water. The automatic regularisation of the outflow from reservoirs, in spite of the varying level of the water; the construction of dams, intakes and conduits; the control of turbines; the generation and distribution of electricity, and its utilisation for traction, lighting and chemical processes—all these, as well as many cognate matters, are dealt with by specially qualified authors, the whole forming a valuable and encyclopædic work of reference.

The second volume is devoted to detailed reports of the visits and excursions, and is beautifully illustrated with reproductions from photographs, besides containing numerous working drawings relating to special features of the various

installations. The photographs are by no means confined to objects of technical interest, but include excellent views of picturesque scenes, which demonstrate that the districts visited were not merely of industrial interest, but also beautiful in themselves. All kinds of manufactures and industrial processes are described and illustrated, showing clearly the industry of the population, and the immense benefits derived from the utilisation on modern lines of the great natural resources of this region. We cordially congratulate the syndicate on the admirable manner in which they have produced this interesting and valuable record of a memorable occasion.

Traité Pratique de Télécommunication Electrique (Télégraphie-Téléphonie). By Edouard Estaunie, Ingénieur-en-Chef des Telegraphes. Paris: Vve. Ch. Dunod.

This work is specially remarkable for the attempt which has been made to treat the various subjects dealt with, in a more methodical manner, and with more attention to details, than has usually been the case. Abandoning the usual practice of describing each complete instrument used in telegraphy in individual detail, the author groups all the transmitters together, and then all the receivers, and so on; thus we have single-current keys, the Hughes transmitter, the double-current key, the Wheatstone transmitter, the wireless transmitter, and so on, grouped together; the idea is systematic in a sense, but beyond its novelty has really little to recommend it, and is rather suggestive of method gone mad. Very full descriptions are given of the Hughes and Baudot apparatus, but when we come to telephone transmitters, only bare principles are illustrated; in fact, the whole work is very unequal in descriptive matter, being very full of detail in some parts, and showing a great absence of the same in others. The book is, however, very full of modern practice (from a French point of view), and is very fully illustrated, and the descriptive text is well put together. The whole book runs to nearly 700 pages, and is quite reliable; it is hardly, however, of much value to any other than a French student.

LEGAL.

Should Electric Cars be Licensed?

The Yorkshire (Woollen District) Electric Tramways Co., Ltd., have been fined 2s. 6d. and costs at Dewsbury for running a car without a license. The case was brought under Clause 37 of the Town Police Clauses Act. The question turned on the definition of a hackney carriage, the town clerk (Mr. H. Ellis) contending that a tramcar came under the term, "other carriages standing or plying for hire."

Mr. Jones, barrister, London, on behalf of the company, pointed out that the trams were not run under either the Tramways Act or the Town Police Clauses Act, but under the Spen Valley Light Railway Order, 1901, which in law had the same power as an Act of Parliament. The company's powers were not confined or limited by the Town Police Clauses Act, for in Sec. 48 of their order it was stated that the company "must" provide such a service of cars as may be reasonably required for the convenience of the public, and should they fail to do so, they were liable to a fine of £5 per day on every day that such service was not run. He quoted cases which had been decided in which companies with special powers had successfully upheld their position that they were not governed by the general Act. He also said that the obtaining of licenses would be a serious matter to the company, as their lines passed through no fewer than 11 separate urban districts.

Mr. Ellis contended that the company were governed by the general Act, and that to run cars without licenses they must have a clause in their order exempting them from such obligation.

On the application of Mr. Jones, the magistrates agreed to state a special case for appeal. Notice of appeal has already been served upon the magistrates and the magistrates' clerk, and it is expected that the case will be heard in the High Court of Justice in October.

Question as to "Extras."

At the Marylebone County Court on Tuesday, before Judge Stonor, Mr. R. N. Cunningham, electrical engineer (trading as R. N. Cunningham & Co.), 171, Edgware Road, W., sought to recover £30 7s. from Mr. Robert Robertson, also an electrical engineer (trading as R. S. Robertson & Son), 141, Edgware Road, the claim being in respect of work said to have been done to order and materials supplied. The case had been remitted from the High Court.

Plaintiff's Counsel stated that defendant had work to be done at large bank buildings in Clifton Road, N.W., at Cambridge Square, W., and at his own premises, 141, Edgware Road, and he sub-let the work to plaintiff. An estimate was given and accepted for a portion of the work, but defendant disputed having ordered certain "extras," in respect of which plaintiff now claimed.

The Plaintiff bore out his counsel's statement, adding that the orders for the "extras" were given verbally.

The Defendant emphatically denied having given orders for the extras. On the contrary, he said, he cautioned the plaintiff against engaging in any additional work.

His Honour came to the conclusion that the plaintiff had not proved an order for certain portions of the work, but that the defendant was liable to pay for the work done at the Edgware Road premises. Judgement was given for the plaintiff for £26, with costs.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending June 2nd, 1903.

Alexandria	Value £16
Amsterdam	724
Antwerp. Elec. fuses	303
Bombay	328
Brussels	45
Buenos Ayres	413
Calcutta	929
Cape Town	24
Copenhagen	209
Delagoa Bay	667
Durban	534
" Teleg. mat.	740
Fremantle	39
Halifax	190
Hamburg. Teleg. mat.	440
Hong Kong	21
La Plata. Teleg. mat.	119
Marseilles	25
Melbourne	126
" Teleg. mat.	25
New York	13
North Atlantic. Teleg. cable	26,000
Odessa	169
Oporto	30
Penang	2,600
Perth	28
Port Elizabeth	291
Shanghai	10
Singapore	69
Sydney	1,064
Wellington	101
Yokohama	108
Total	£36,400

Week ending May 31st, 1904.

Alexandria	Value £30
Beira. Teleg. mat.	152
Bombay	24
Buenos Ayres. Teleph. cable	70
Calcutta	481
" Elec. machinery	186
Canary Islands	19
Cape Town	554
Channel Islands	46
Colombo	20
" Teleg. mat.	18
Durban	497
" Teleg. mat.	25
East London	29
Emden	75
Fremantle. Elec. machinery	34
" Teleg. mat.	180
Gibraltar	525
Hamburg	50
Hong Kong	524
Malta	18
N. Atlantic. Submarine cable	16,100
Oporto	163
" Teleph. mat.	220
Ostend. Teleg. instruments	126
Penang	123
" Teleph. mat.	23
Perth	249
" Elec. machinery	80
Piræus	60
Port Elizabeth	16
Shanghai	24
Singapore	88
Stockholm. Teleg. wire	61
Sydney	278
" Elec. machinery	1,195
Wellington	57
Total	£22,366

Foreign Goods Transhipped.

Durban. Elec. lamps	Value £36
Calcutta. Telephones	Value £6
Durban. Elec. apparatus	295
Ttoal	£356

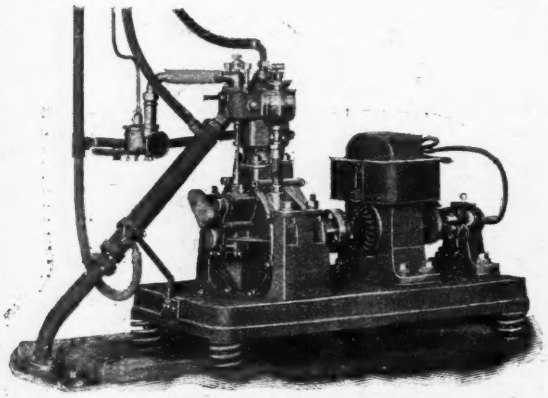
Electric Tramway and Railway Exhibition, 1905.—Preliminary arrangements for the third Electric Tramway and Railway Exhibition, to be held in the Royal Agricultural Hall, Islington, London, N., from July 3rd to 14th, 1905, are now practically completed. We understand that although the first announcement of the date was not made until a few weeks ago, numerous applications have been received, and more than two-thirds of the space in the main hall has already been allotted. Several important firms have applied for double the amount of space that they occupied in the last exhibition; and although there will be some change in the plan of the floor, it will be very similar to that in 1902. The promoters of the exhibition will, as in previous years, have the co-operation of the leading tramway managers and engineers in the country, including also the general manager of the Central London Railway, who have consented to act as an advisory committee. The members of the committee are as follows:—Messrs. Alfred Baker, C. R. Bellamy, G. C. Cuningham, A. L. C. Fell, C. W. Gordon, J. B. Hamilton, E. G. Mawbey, J. M. McElroy, J. Erskine Pitcairn, A. E. Le Rossignol, and John Young. Mr. Jas. W. Courtenay will act as chairman of the Exhibition, as in previous years, and Mr. A. M. Willcox as secretary. Inquiries should be addressed to *The Tramway and Railway World* Offices, Amberley House, Norfolk Street, London, W.C.

The British Crown Lamp.—We have received a circular relating to this English-made lamp, accompanied by a certificate from the Westminster Electrical Testing Laboratory, showing the following result of a test:—"The test was stopped at 1,000 hours, both lamps being still unbroken. The mean figures for both lamps for 1,000 hours' burning work out as follows:—Candle-power, 13·4; watts, 61·2; watts per C.P., 4·57. The results are considerably above the average obtained by us on lamps of all makers during the last two years." The circular, giving further particulars, will be sent to applicants by the Bryant Trading Syndicate, 230, Pentonville Road, N.

Electrical Illuminations.—For the Charing Cross Hospital Mask and Domino Ball at the Royal Albert Hall, on Tuesday, a beautiful scheme of decoration was specially designed by Monsieur H. Véry, of Paris (who are represented in London by Messrs. L. and R. Heymans). The scheme comprised a large hori-

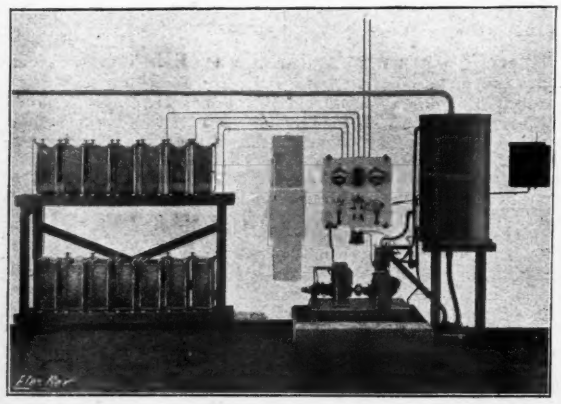
zontal sun composed of 40 beams of irregular lengths, illuminated by some 800 gold-tinted electric lamps, surrounded by a sunflower, and on the three-box tiers were garlands of luminous flowers and foliage, with groups of a large rose, shamrock, and thistle design at each column, with special decorations and illuminations for the Royal boxes. In addition there were two huge garlands of luminous flowers forming a drapery, and hanging from the ends of the balcony, passing in front of the organ, the whole being lit with some 2,500 coloured electric lamps, forming a blaze of light and colour.

Domestic Electric Lighting Set.—A simple electric lighting outfit has been arranged by the Siemens-Schuckert Co., of Berlin, and is illustrated herewith. It comprises a benzine or alcohol motor of 3 or 4½ H.P., driving directly a dynamo of special design at 1,200 r.p.m., which, with the engine, is mounted on a bedplate carried by springs; a battery of 14 storage cells having a



BENZINE ENGINE AND DYNAMO.

discharge rate of 216 or 220 amperes for 3 to 10 hours; and a marbe switchboard, which bears all the necessary apparatus, including an induction coil for the ignition of the motor. The motor is of very simple construction, and is completely enclosed, the only externally visible moving part being the rod of the exhaust valve. The rate of admission of the spirit is automatically controlled. Cooling is effected by a water jacket, either fed by a continuous flow of water from the mains, or kept in circulation by a raised tank; in the former case the consumption of water is 30 to 40 litres per KW.-hour. Lubrication is also automatic and positive. Combined with



COMPLETE DOMESTIC ELECTRIC LIGHTING PLANT.

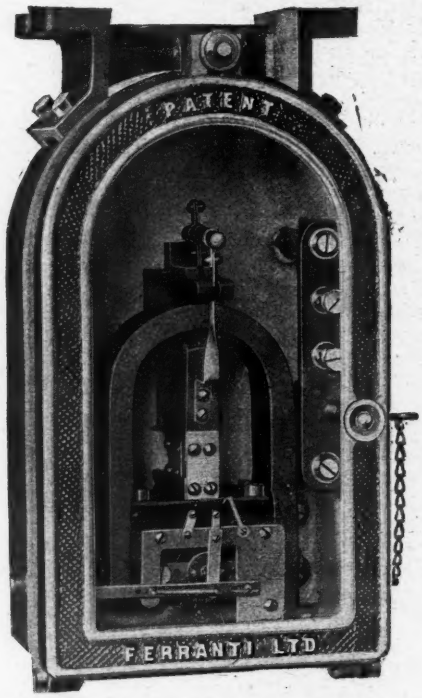
the motor is an exhaust box, and a special exhaust silencer is fixed on the end of the exhaust pipe to soften the escape of the waste gases. The benzine reservoir is fixed outside the wall of the room, and is completely enclosed; it is filled by means of a small pump. The whole apparatus has been designed with a view to ensuring reliability and simplicity of working, and ease of upkeep, while it can readily be operated by any person of average intelligence.

France.—La Société des Accumulateurs Electro-tube (Hanaire & Co.) is the name of a new company which has been formed at Levallois-Perret, near Paris.

La Compagnie d'Electricité Thomson-Houston de la Mediterranée reports a profit of £35,060 for the last financial year.

Asylum Installation.—The Hart Accumulator Co., Ltd., has secured the order for a battery of 122 of its standard lighting type cells, for the Gransha Lunatic Asylum, Londonderry.

Ferranti Reverse Current Relay.—Several types of reverse current devices have been put on the market, generally consisting of two coils, one connected in the main circuit and the other as a shunt across the bus-bars. These all labour under the disadvantage that the current at which they operate varies considerably with the bus-bar voltage. The accompanying figure represents the reverse current relay recently put on the market by Messrs. Ferranti, Ltd. (Garrard's Patent). It consists of a moving-coil polarised relay, in which the moving coil is operated by the fall of potential across the ammeter shunt. With the current in the forward direction the contact carried by the moving coil impinges against a stop; on the occurrence of a reverse current of a certain magnitude, which is fixed by the amount to which the controlling spring is set up, the moving coil rotates, and closes the auxiliary circuit mentioned below. This auxiliary circuit is one of eight Leclanché cells, and on being completed causes a small electro-magnet to attract its armature. The latter closes a pair of heavy carbon contacts which complete the circuit of the tripping coil of the circuit breaker. The object of the auxiliary circuit is to remove the sparking which is due to the induction of the trip coil, from the necessarily light contacts carried by the moving part of the



GARRARD'S PATENT REVERSE CURRENT RELAY.

relay proper. The trip coil is connected across the bus-bars, and is constructed with such a factor of safety that even if the bus-bar volts should fall to one-sixth of their normal value it would be sufficiently strong to open the circuit breaker. Generally speaking, the connections are so made that a coloured lamp is lighted immediately the relay operates, thus indicating at a distance which circuit breaker has operated. The relay is provided with a push-button; on pressing this the device is caused to work and the circuit breaker to open. If desired, parallel push buttons can be arranged at a distance from the switchboard, so that the circuit breakers can be operated therefrom. Of course the whole relay can be placed at a distance from the main board if it be wished. The relay can be connected with any direct current circuit. It is already in operation in several supply stations in this country, where it has given satisfaction—notably, at Hackney Electricity Works, recently described in the ELECTRICAL REVIEW.

Book Notices.—"Etude sur les Résonances dans les Réseaux de Distribution par Courants Alternatifs." By G. Chevrier. Paris: *L'Eclairage Electrique.*

"Dampfturbine." By Gabriel Zahikjanz. Berlin: Bickel and Co.

"Electrotechnique Appliquée." By A. Mauduit. Paris: Ch. Danod. 25 f.

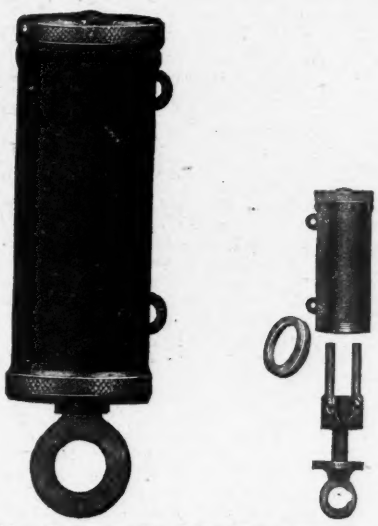
Messrs. Whittaker & Co. will publish shortly a new work by Mr. H. M. Hobart, M.I.E.E., entitled, "Electric Motors: their Theory and Construction." This work will deal fully with the design of induction motors and of continuous current motors, and will be characterised by considerable departure from conventional methods, and it is believed that new light will thereby be thrown on the subject.

Japan as a Buyer of American Electrical Goods.—The *Western Electrician*, May 7th, says:—"Japan continues to occupy the foremost place among foreign buyers of American electrical machinery, despite the war, or possibly in consequence of it. It was only in February of this year that Japan reached the first place among the nations importing electrical machinery from the United States, and in March it again headed the list, and with a larger amount, the figures being $119,856 out of a total of $510,707 in

February, 1904, and $201,617 out of a total of $596,073 in March, 1904. In other words, 23 per cent. of all American exports of electrical machinery went to Japan in the first month of the war and 33 per cent. in the second. These figures are very interesting; they seem to show that the war has increased the demand for electrical machinery, which may very easily be the case; but it may be, too, that ordinary industrial operations happened to culminate in heavily increased imports just at the time of the beginning of the war. Whatever the reason, Japan is just at present our best individual customer for electrical machinery. But if all British possessions are taken together, we send more electrical machinery to the various portions of the British Empire than to the Mikado's realm. In March, for instance, our exports of such products to British possessions amounted in value to $293,743. It is interesting to note that Japan and the British Empire together took $495,360 worth of the $596,073 of exports of electrical machinery from the United States in the month of March. Perhaps statistics such as these may explain in some measure the friendly feeling that exists between the United Kingdom, Japan and the United States."

Catalogues and Lists.—We have received from MR. HERBERT PERKIN, of Park Row, Leeds, a catalogue of his various patterns of hack saws for hand and motor use; the list also shows portable rail saws, track drills, and other labour and time-saving appliances.

A new list of electric street lighting apparatus, made by the Keighley Electrical Engineering Co., Ltd., has been sent to us by MESSRS. RICHARD WOODS & CO., of Sanctuary House, Westminster, who are the sole agents. The specialities shown include a weather-proof Nernst lamp-carrier, the Keighley lamp pillar switch adapters for street lanterns. The Keighley patent traction pillar switch, of which we give illustrations, is also shown in the list. This switch is made in single-pole one-way or two-way, or double-pole (one-way), and with or without fuse. It has been specially designed for



THE KEIGHLEY TRACTION PILLAR SWITCH.

fixing to traction poles, and for use on traction voltages for either arc or incandescent lamps, its capacity being anything up to 20 amperes. The top of the switch case, which forms the terminal box, is designed as a sealing chamber also. For renewing a fuse the operating part of the switch is withdrawn entirely, as shown in the illustration, so that absolute safety to the trimmer is ensured. Messrs. Woods are also supplying cables, wires, accessories, motors, dynamos, fuse-boxes, &c., as made by the Keighley Co.

Some circulars relating to blue "Ironware" pipes have come to hand from HAMBLET'S BLUE CO., LTD, of West Bromwich.

The excellent qualities of Uralite, the fire-resisting material, have already been detailed in the columns of the ELECTRICAL REVIEW, but those who desire fuller information can find it in the artistically illustrated catalogue which has just been issued by the BRITISH URALITE CO., LTD., of 50, Cannon Street, E.C. A number of nicely executed illustrations are given, showing a few of the applications of Uralite, which has been adopted for a hundred different trades and purposes. The pictures include one of a Great Northern and City Railway carriage with Uralite insulation.

An 8-pp. pamphlet has come to hand from MESSRS. ISAAC STOREY AND SONS, of Empress Foundry, Manchester, giving particulars of their Stella brand alloys of manganese copper and bronze, phosphor copper and tin, silicon copper, and anti-friction metals.

From MESSRS. MATTHEWS & YATES, LTD., of Swinton, Manchester, we have received a small pamphlet giving "Facts Relative to the Ventilation of the House of Commons." The firm's cyclone electric fans are in use for ventilating the lobbies, committee rooms, &c. a special type of motor-driven fan, also of their make, being employed in the "House" itself.

The CONSOLIDATED ENGINEERING CO. LTD., which has an extensive foundry at Gotha Ironworks, Slough, with an equipment of modern appliances for turning out iron castings up to 5 tons, has sent us a circular of its patent coil friction clutches.

The RHODES ELECTRICAL MANUFACTURING CO., LTD., of 70-71, Bishopsgate Street Within, E.C., has issued a preliminary advance sheet of its prices for single and polyphase alternating-current motors up to 15 H.P. Another loose leaflet gives weights, dimensional, and price particulars of the R.E. continuous-current motors and generators up to 60 H.P. A full catalogue of the company's motors is to be out shortly.

From the FOREST CITY ELECTRIC CO., of Manchester, there has come to hand a finely-illustrated catalogue of their well-known "Protected" rail bonds. The company claims to have sold over three millions of these bonds. In the introductory pages the conditions to be complied with in order that bonding may be well and properly done, are briefly stated, and the special points of the "Protected" bond are detailed. Some general data of interest in connection with the subject is followed by well-executed illustrations of a few out of the hundreds of different types of bonds which have been designed for electric traction service by the Forest City Co. The other matter included, relates to the location of bond holes, the spacing of rails, several types of bond compressors, rail-bond testing sets, cross bonding, tables of prices, "Roll Drop" commutator segments, and the Cleveland track drilling machines.

A copy of their latest catalogue of Nernst lamps has come to hand from the NERNST ELECTRIC LIGHT, LTD., of 82, Victoria Street, S.W. The "A" and "B" types of lamp and spare parts for same are shown, the "Brilliant" and "Candle" lamps are described, also a variety of fancy globes, reflectors, holophane globes, pole-testing appliances, and electrolier fittings. An account of the Nernst lamp applied to use in projection lanterns, and a table of candle-powers of the lamps, are also given.

MESSRS. GENT & CO., LTD., of Leicester, are bringing out some new devices for fire prevention, and these are described and illustrated in a new pamphlet which they have just issued from the press with the title "Tell-Tales." The watchman's relief alarm attachment, which can be added to the firm's patent tell-tale clock, ensures the ringing of a loud bell at some suitable place if a certain interval passes without a record being made on the clock. Among the other features of the pamphlet are the magneto-generators and connection boxes, which supersede the ordinary Leclanché battery in warehouses and works where pegging stations are situated at great distances. The generators are fixed at each station, and the watchman is provided with a small handle or crank, which he inserts and turns, thus making his record on the distant chart. The company will send a copy of the list on application.

The GENERAL ELECTRIC CO, LTD., has issued a second edition of its motor accessories list, in which are particularised ignition coils, sparking plugs, contact breakers, switches, batteries, &c., also small motor-generators for charging accumulators, instruments for testing, and other requisites for the electrical arrangements of the motor-car or cycle. Attention has been given to the designing of ignition coils to suit the requirements of users of high-speed engines, and they are supplied in various forms and sizes with or without tremblers. Among the sparking plugs shown is the "protected" pattern, which is designed to give absolute protection against leakage in wet weather. Various forms of switches are described, also accumulators of the "Geeko" type which are supplied in two qualities and fitted with celluloid cases with splash proof vents. They have corrugated celluloid separators, which prevent short circuits. Two other forms of battery are illustrated and described, viz, the "Geeko" dry cell, and the Sack form of Leclanché. The latter form can be carried dry for use in emergency, and charged by means of a special siphon, which can also be used to empty the battery when the cells require fresh solution. They can be hermetically sealed by means of a spring cover, and are made to withstand violent vibration. The other features of the list include measuring instruments, arranged for fixing to the car dash-board, and accumulator charging apparatus to run from electric lighting mains (alternating or continuous). A charging board with lamp resistances, and special adaptors of a new form are also illustrated; the lamp remains alight whilst charging is going on. The General Electric Co.'s "Progress" sheet for May contains details of several improvments in watertight electric light fittings for ships, mines, mills, and factories; a new pattern cigar lighter, and a special ceiling rose with a brass cover, which is fibre lined (there are no metal parts at the back of the porcelain). A watertight floor plug with brass screw cap obviates risks of injury by water, &c., when the water socket is not in use.

A circular of cheap induction coil battery wall telephones has come to hand from the BERLINER TELEPHONE MANUFACTURING CO., LTD. We understand that the originality displayed by the company's publicity department in the preparation of its ELECTRICAL REVIEW advertisements has elicited numerous encomiums through the medium of the post. The recent "Births, Marriages, and Deaths" announcement has, we understand, been especially successful in this way.

London United Tramways.—Notwithstanding the inauspicious climatic conditions prevailing in the Thames Valley during the Whitsuntide holidays, particularly on Sunday and Tuesday, the operations of the London United Tramways Co. show excellent results. On Monday the whole of the company's rolling stock was requisitioned into service to cope with the enormous crowd visiting Hampton Court and Hurst Park races, when 350,000 passengers were conveyed by the electric tramcars. The total number of passengers carried during the three days exceeded 675,000.

Imports of Electrical Goods and Apparatus.—The value of the foreign electrical goods and apparatus imported into this country during April last is returned at £58,937, which contrasts with £68,630 in the preceding month and £61,864 in April last year. So far as the year has gone, however, there has been a slight increase in the imports, the total for the four months ending with April being returned at £266,997, as against £232,898 in the corresponding four months of 1903.

Bankruptcy Proceedings.—The accounts under the failure of David Todd Cameron, electrical engineer, of Saltash, and formerly of St. Birdeaux and Devonport, show gross liabilities amounting to £234 4s. 4d.; unsecured liabilities, £213 8s. 4d.; assets, £49 11s.; and a deficiency of £184 13s. 4d. The debtor attributes his failure to undue competition and cutting of prices. Debtor commenced business last November at Devonport under the style of D. T. Cameron & Co., with a capital of about £200. On April 19th his stock was sold under a distress for rent, and realised £40 5s.

A meeting of the creditors of John James De Lacy and Howard Kyan De Lacy, trading as De Lacy Bros., electrical engineers, of Liverpool, was held on May 25th, when it was stated that the liabilities amounted to about £1,700, and the assets to about £1,100. It was decided to apply for an adjudication of bankruptcy, and Mr. Thos. Tranter was appointed trustee, with a committee of inspection.

A sitting of the London Bankruptcy Court was held last Tuesday, before Mr. Registrar Linklater, for the public examination of C. J. Smith, electrician, 23, King Street, Regent Street, W. The debtor filed his own petition on April 14th. He states that the business was carried on for many years by his father, at whose death in June, 1901, it passed to his mother. Three months later the latter verbally transferred the business to him on the understanding that he paid her at some future time the amount of the outstanding book debts, about £900. He has paid £400 on account thereof. Shortly before the failure the Sheriff levied an execution, and sold off the stock, plant and machinery. Want of capital, bad debts, and depression in trade are the reasons assigned for the failure. Mr. E. S. Grey, Official Receiver, applied for an adjournment of the examination, to enable the debtor to furnish further accounts, and by consent of all parties the hearing was ordered to stand over until June 28th.

Liquidations.—The Dover Electricity Supply Co. is winding up voluntarily, with Sir W. H. Crundall and Mr. R. P. Sellon as liquidators.

A meeting of the Giffre Electro-Chemical and Power Co. is to be held at 11, Queen Victoria Street, E.C., to hear an account of the winding up from the liquidator, Mr. F. H. Haviland.

Trade Announcements.—We have received the following letter from Messrs. Baxter & Caunter, of 86, Charing Cross Road, W.C.:—"*Re* paragraph appearing in the ELECTRICAL REVIEW of 20th ult., page 827, respecting the Electric and Ordnance Accessories Co. agency held by Mr. Jenkins for motors, dynamos, starters, &c. This paragraph is very misleading, and we shall feel obliged if you will kindly make the position quite clear in your next issue. As you are aware, we are the sole agents for Messrs. Newtons, Ltd., Taunton, for the sale of their motors and dynamos, under an agreement for a term of years. It was, therefore, impossible for us to act for the Electric and Ordnance Accessories Co. in this respect, and Mr. Jenkins has been appointed their agent for the sale of motors and dynamos only, we still retaining the sole agency for the sale of all other electrical material manufactured by the Electric and Ordnance Accessories Co. We apologise for troubling you in this matter, but we have had so many applications from our numerous friends, asking us the exact position, that we fear the statement appearing in your paragraph is seriously prejudicing our position with the trade."

Messrs. Clark & Jessop, electrical engineers and wiring contractors, have opened showrooms and stores at 32, Abingdon Street, Blackpool.

Messrs. E. Newbald & Co., electrical engineers, intimate they have removed from 18, High Street, to new business premises at Court Road, High Street, Sutton.

Mr. J. Charters notifies that he has removed to larger premises at 261, West George Street, Glasgow.

Messrs. J. H. Tucker & Co., late of 3, Bury Street, W.C., notify us that, in order to deal with their increasing business, they have removed to larger premises at 217, Shaftesbury Avenue, W.C., to which address all communications from the South and East Coast districts should be sent. Mr. G. T. Baker, who has been the London and District representative of the firm for many years, will continue in charge. The head office will still be at Sampson Road North, Birmingham.

LIGHTING AND POWER NOTES.

Barrow-in-Furness.—Below we give a few details of the financial results of the working of the Corporation's undertaking for the year ended March 31st, 1904 (fifth year):—

	1904.	1903.
Capital expended	£78,575	£67,373
Total revenue } exclusive of public lighting, maintenance, &c.	9,248	7,099
Total costs } exclusive of public lighting, maintenance, &c.	4,575	3,513
Gross profit	4,673	3,586
Interest on loans	2,288	1,607
Sinking fund	1,907	1,464
Balance on year's working	+478	+425
Capacity of plant	1,025 KW.	525 KW.
Maximum load, including traction for 1903-4	793 KW.	441 KW.
Number of lamps, 8-C.P., connected	44,682	36,856
Number of units sold	540,146	403,596
Average price obtained } exclusive of public lighting, maintenance, &c.	4·01	4·17
Works costs per unit } exclusive of public lighting, maintenance, &c.	1·573	1·579
Total costs per unit } exclusive of public lighting, maintenance, &c.	2·089	2·09

Birmingham.—A L.G.B. inquiry was held on 31st ult. into an application by the City Council to borrow £447,129 for the electric supply purpose. It was explained by the town clerk that in 1899 the Corporation became the owner of the Birmingham Electric Supply Co.'s undertaking, which had only been able to supply a limited area. The Corporation, however, was empowered to supply the whole city. The works of the old company being inadequate, new premises were required, and in 1902 the L.G.B. sanctioned the borrowing of £251,974, which included £128,890, the estimated cost of the erection and equipment of a generating station. Only £84,196 of the loan sanctioned had been expended, and the Board had been requested to cancel the sanction, so far as it had not been acted upon, and to grant a further loan. In 1906 an extensive system of tramways would come under the control of the Corporation, and thus there would be a large expenditure on tramways alone. In 1911, when the whole of the tramways in Birmingham would come into the hands of the Corporation, the outlay would be even greater. There was also an increasing demand for energy for private lighting and power, and the present works were taxed to their utmost capacity. In the scheme for the new generating station the Corporation were arranging both for tramway and lighting and power supply work.

Brighton.—The E.L. department has made a profit of £38,335, and a balance of £7,984 was brought forward from last year. It is proposed to devote £3,250 to the relief of the rates and £4,734 to the reserve fund—after meeting statutory financial charges.

Bristol.—The report of the working of the E.L. undertaking for the year ended March 25th, 1904, shows that, notwithstanding the fire at Xmas, substantial improvement has been made. The gross receipts were £61,372, and the expenditure £29,841, leaving as gross profit £31,531; interest and dividends amounted to £13,967; set aside for sinking fund, £9,357. £2,060 has been placed to reserve, raising it to £7,000; £5,026 to depreciation and contingency account, raising it to £4,000; £1,194 has been carried forward. For private lighting 2,461,515 units were sold, for power 1,224,676, and for public lighting 613,313, a total of 4,299,504, or an increase of 889,746. Mr. Faraday Proctor, the engineer, reports that lighting and power customers have continued to increase, and that the coal bill per unit has been reduced by 10 per cent. All the other costs are slightly lower than those of last year, and and although the revenue has fallen from 3·44d. to 3·18d. per unit, the net profit has increased from ·413d. per unit in 1903 to ·46d. per unit in the past year. Mr. Proctor adds that the additions to the lighting demand have been greater than in any previous year, whereas the additional demand for power has been nearly double that of last year, and about three times that of the previous year.

The Electrical Committee reports that, having regard to the continued growth of the electricity department, it deems it advisable that the second instalment of the Avonbank works shall be completed, and the foundations of the third instalment put in hand at once, at an estimated cost of £89,000, including £74,000 for machinery and £15,000 for the construction of foundations. As a result of the fire at the Temple Back works in December last, the Committee recommends that fire-proof switch-rooms shall be constructed at an estimated cost of £3,980. Two additional direct current generators have been purchased at a cost of £1,060. It is desirable to obtain additional plant at Temple Back at an estimated cost of £10,960. In regard to the external system, the Committee desires to provide additional mains, meters, sub-stations and transformers at an estimated cost of £21,500. It recommends that it shall be authorised to apply for loans to the amount of £126,500.

Burnley.—The report of the Corporation's electrical engineer shows that during the past year the output had increased 34 per cent., and reached 1,739,799 units. The equivalent 8-C.P. lamps in use was 37,333, and 63 motors were connected. The total revenue amounted to £16,838, the gross profit £9,439, and after providing for interest and sinking fund the net profit was £5,123, compared with £3,552 in the previous year.

Chichester.—The T.C. has written to the B. of T. asking as to the position of the Council with respect to the proposed transfer of the E.L. order.

Clydebank.—The Clyde Valley Electric Power Co., in view of the near completion of its Yoker station, has asked the T.C. whether it intends to take a supply. The company and the Council have an agreement, alternative terms being mentioned for supplying for public purposes, at the Council's option. The agreement provides for a direct current supply, the reason for which stipulation was that the Burgh buildings were wired for that supply. It was the opinion of the company, that the alternating current supply, with a periodicity of 50 cycles, would be the better, and that in the event of the Council taking a supply, the company would bear the expense of altering the wiring of the buildings.

Dundee.—The returns of the electricity department for the past year show a total revenue of £27,227, some £4,000 more than in the previous year. The working expenditure amounted to £18,128, and the balance of £9,098 was further reduced by financial charges to £24, being the surplus on the year's working. The year's output showed an increase of 300,000 units. It was decided to recommend the Council to sanction the reduction in price of energy for traction purposes, from 1½d. to 1¼d. per unit. The T.C. after inspecting the alterations to the electricity station, recorded its appreciation of the work of the engineer and staff in connection therewith.

Edmonton.—At a special meeting held on 31st ult., the T.C. reviewed the past action of the Council in regard to electric lighting. A scheme prepared by Mr. Hammond, which was estimated to cost £44,000, was accepted by the last Council, but the elections in April resulted in the return of a majority opposed to his proposals, and he was ordered to proceed no further than with the preparations of the plans and specifications until further instructions were given to him. The Council has decided to ask the Tottenham and Edmonton Gas Co., and the North Metropolitan Electric Power Supply Co., whether they are prepared to lease its prov. order, and on what terms, and to request Mr. Hammond to submit a modified scheme for the supply of electricity in the compulsory area mentioned in the order.

Farnborough.—The B. of T. has again written the U.D.C. inquiring whether any further steps have been taken by the Council to carry out the proposal to transfer its powers under the E.L. order to a company. The clerk reported that a reply from the Power and Traction, Ltd., on the subject was awaited.

Germany.—The Gottessegen Colliery Co., at Lottringhausen, is about to put down an electrical plant for power purposes.

Gravesend.—The T.C. has resolved to apply for an extension of its E.L. order so as to include the parish of Rosherville.

Hastings.—The T.C., on the recommendation of the of the Electricity Committee, urging that the outlay was on economical grounds imperative, has rescinded the resolution adopted at its last meeting, and decided to expend £3,416 10s. to provide new machinery, &c., at once.

Heston and Isleworth.—The U.D.C. has given notice that it will be in a position shortly to supply energy for light and power, and that all persons who agreed before the 24th ult. to take a supply will have services laid from the mains to their premises free of cost. No charge will be made for energy for the first month's working. The charges will be:—For lighting, 5d. per unit, with discount; meter rental, from 1s. per quarter; power, up to 750 units per quarter, 3d., and 2d. after; meter rental, from 2s. per quarter. Premises may be wired and fitted free of cost, the charge for energy to be 5½d. per unit, consumers having the right of purchase.

Hull.—The returns of the electricity department for the year ended March 31st last showed that the output reached 3,017,188 units. The capital outlay was £276,848, the revenue £37,887, and gross profit £18,227. Financial charges and depreciation absorbed £16,587 of the amount, and the balance of £1,639 was added to the reserve fund, bringing the latter up to £11,752. The Committee considered applications from Messrs. Reckitt & Son for a supply of energy for lighting and power estimated at 560,000 units per annum, and from the N.E. Railway Co., who estimate their requirements at 1½ millions per annum for similar purposes. In both cases it was decided to enter into negotiations with the object of providing a supply.

Ilford.—It has been arranged by the Lighting Committee and the Tramways Committee of the U.D.C. that the charge for energy for the tramways shall be 1½d. per unit.

Little Lever.—Replying to the inquiry of the Lancashire Electric Power Co. as to whether the U.D.C. is prepared to take electricity in bulk, or whether it will grant authority to the company to supply to those desiring it, the Council states that it declines to surrender its powers in the E.L. Acts, but is willing to take into consideration any special demand for the supply of energy which may arise in the district.

London.—BERMONDSEY.—The Lighting Committee presented the estimates for next year, which include an estimate of £69,266, made up of £2,952 for land, £8,999 buildings, £10,844 machinery, £37,185 mains, and £2,058 accumulators, this being part of the extensions shortly to be taken in hand.

Louth.—The agreement between the T.C. and the National Electric Construction Co., is to the effect that the Corporation shall borrow £17,000, and, with this sum as capital, the company shall install electricity within the borough at a price to be fixed by a subsequent construction agreement. The agreement is for 20 years, during which period the company will make yearly payments to the Corporation, sufficient for the payment of interest on and repayment of loan.

Mussoorie.—We have received further details of the scheme which has been drawn up for the electric lighting of this municipality, a popular hill station in Bengal, where some of the English population reside during the hotter seasons. At present the town is badly lighted with a few small oil lamps, and is also threatened with a water famine. Within 2½ miles are the Kempti Falls, 821 ft. in height, where, in a very dry season, there is a fall of 6½ cb. ft. per second. It is proposed to erect a power station at the foot of the falls, supplying energy for lighting the municipal area, and power for pumping water from some springs to a reservoir standing well above the town.

The turbine house is to contain four turbo-generators of 35-KW. each, 60 cycles per second, working at a pressure of 5,000 volts, and two turbo-exciters. The Pelton wheel type of turbine is recommended. Two sets of mains are to leave the central station switchboard, one to the pumping station, where two 150-H.P. pumps are to be installed, only one of which will be used at a time. Within the town 12 transformer stations are to be erected, where the energy is to be transformed down to 230 volts for distribution. A scheme for the public lighting has also been drawn up, comprising 45 arc and 176 incandescent lamps.

Ormskirk.—The Board of Guardians has decided to apply to the L.G.B. for a loan of £5,000 for the purpose of installing the E.L. at the workhouse.

Pembroke (Ireland).—A L.G.B. inquiry has been held into the application of the District Council for £25,000 for E.L. extensions; evidence was given both for and against the proposed loan.

Penge.—The Blackheath and Greenwich Electric Light Co. asks us to make the following correction to last week's note under the above heading:—"The Beckenham U.D.C. has not yet concluded the purchase of that portion of the Crystal Palace Co.'s undertaking within the Penge district. The laying of mains in Penge has been very seriously delayed owing to the delay in obtaining possession of the Crystal Palace undertaking, but the company is advised by its solicitors that the B. of T.'s approval to the transfer may now be expected in the course of a few days, when operations will be immediately commenced in both the Crystal Palace and Penge areas."

Our local correspondent says that the Penge U.D.C. has received a letter from the Beckenham U.D.C., asking whether, and upon what terms, it could extend its E.L. system from the district boundary along Beckenham Road, in the Penge U.D., in order to supply Crystal Palace Park Road, within the Beckenham U.D.

Rickmansworth.—The U.D.C. has resolved to petition the B. of T. to cancel the E.L. order granted to a company for lighting the district, as it had not been carried out in accordance with the promise of the undertakers. The guarantee deposit required by the B. of T. had not been sent, the company stating, that pending the completion of arrangements for the working of the order in conjunction with the Northwood undertaking, they beg to be excused.

Rochdale.—The Electricity Committee has recommended the T.C. to apply to the L.G.B. for a loan of £42,405 for extensions at the electricity works. The additional plant is required for supplying energy to the tramways. The amount is made up as under:—Buildings, £4,500; three 200-KW. turbo-alternators and one 200-KW. motor-alternator, £5,800; 412-KW. steam dynamo for D.C. supply, £3,750; sub-station plant for lighting purposes, £2,500; three Lancashire boilers, £3,150; superheaters, &c., £2,750; condensing plant, &c., £2,650; feed pumps, tanks, &c., £500; switchgear, &c., £2,950; cables, meters, and services, £10,000.

The question of supplying energy to Littleborough is being considered by the Council.

Saxony.—The municipal authorities of Reichenau have granted a concession to the Allgemeine Electricitäts Gesellschaft, of Berlin, for the establishment of a generating station for lighting the town for a period of 50 years.

South Shields.—A L.G.B. inquiry was held on the 26th ult., into an application by the Corporation for sanction to borrow £12,046 for E.L. purposes. The town clerk explained that £7,215 was required for new works in connection with the undertaking, it being necessary to make provision for at least 500 new consumers, and £4,831 in respect of excess expenditure on previous sanctions.

Stockport.—The T.C. has reduced the price of energy for lighting to 4d. per unit, the charges for power ranging from 3d. to 1½d.

Stoke-on-Trent.—The T.C. has resolved to apply to the L.G.B. for sanction to borrow £1,250 for the provision of electric light fittings in the municipal buildings.

Stourbridge.—It was reported at a meeting of the U.D.C., on the 30th ult., that the Midland Electric Corporation for Power Distribution, had confirmed the offer to supply electricity in bulk to the Council, referred to at the inquiry recently held by the L.G.B. The Council's electrical engineer was instructed to prepare an estimate of the capital expenditure under the scheme to supply electricity in bulk, and the report had been discussed at a special meeting of the Committee. It was resolved to interview the representatives of the Midland Electric Corporation again, and a further report is to be made to the Council. The Committee recommended that, meanwhile, a further representation be made to the Board of Trade with the view of assuring the non-revocation of the order.

Tunbridge Wells.—A private company having offered to supply the electric light cheaper than the Corporation, the opinion of consumers is being invited as to whether the municipal undertaking should be sold, and a memorial is to be presented to the Council.

At a meeting of the T.C. held on the 1st inst., a proposal to extend the area of supply, to undertake free wiring and provide motors on the hire system, was, after considerable discussion, lost by 9 votes to 13.

Walthamstow.—The U.D.C. on Friday last resolved that three 275-H.P. Westinghouse gas engines and dynamos, with a spare armature, be provided as additional plant for the generating station The electrical engineer reported that since the loan of £5,200, which

was sanctioned by the L.G.B. for free wiring, had been expended, there had been a great falling off in the demand for small house property being electrically lighted. He suggested that a sum of £500 be taken from the profits of the undertaking and utilised for the purpose of carrying out installations, and the number of points in each house be strictly limited to 6, which will provide 8 lights. The average cost of carrying out an installation of 8 lights, when the work is done by the Council's own men, is £5. Eight lights would be of small use to consumers in large houses, such as those in the Upper Walthamstow district. Some of the larger houses for which an installation of 8 lights would not be sufficient, had been canvassed, and while the tenants expressed their willingness to take a supply, they are not prepared to go to the initial cost of wiring, &c. Tenants in this class of property are good consumers, and in order to meet them he suggested that they be allowed 16 lights on the free wiring system, providing they are willing to pay an additional ½d. per unit, making 1d. per unit in all for the accommodation of free wiring. After discussion, the Council directed the clerk to write to the L.G.B. inquiring if it would entertain an application for sanction to an additional loan for free wiring. It was reported that the Great Eastern Railway Co. had applied for a reduction in the price of energy for lighting purposes (at present 3·7d. per unit net), and made a proposal that the rate be fixed on the maximum demand system. The U.D.C. has written to the company stating that it cannot make any alteration in the price charged. A further report from the electrical engineer stated that, in view of recently erected 32-C.P. lamp brackets having been found satisfactory, the question of electrically lighting the whole of the side streets might be taken into consideration. Upon the recommendation of the Lighting Committee, the electrical engineer was instructed to prepare a list of the existing lamp-posts in side streets, and the total cost for the conversion of same for electric lighting. It was resolved to ask the L.G.B. for sanction to borrow an amount sufficient to erect arc lamps and lay cables along the tramway route.

Walton.—It was stated at a meeting of the U.D.C. on May 24th that the Gas Co. had petitioned against the agreement between the Council and the Electric Supply Co., and the opinion was expressed that, if necessary, the Council should petition in favour of the Bill.

Watford.—On May 24th a L.G.B. inquiry was held concerning the application of the U.D.C. for a loan of £8,000 for E.L. purposes. There was no opposition.

Wood Green.—A L.G.B. inquiry was held recently into the application of the U.D.C. for powers to borrow £43,200 for E.L. purposes. The chief opposition to the scheme is the North Metropolitan Electric Power Corporation; the local gas company also sought the insertion of the "Bermondsey" clause in the Council's order.

TRAMWAY AND RAILWAY NOTES.

Brighton.—The Works Committee of the T.C. has considered a suggestion from Mr. Magnus Volk with regard to Volk's Electric Railway and the proposed Rottingdean tramroad, that cars should be permitted to be worked on the two systems without passengers having to change cars. Mr. Volk also requested the Corporation to waive its right to take over the electric railway before the end of the lease; and in a subsequent letter he agreed, if the concession was granted, to give a sum of £250, and a similar sum in 12 months, for the purpose of advertising the borough. The Committee was willing to agree to Mr. Volk's cars running over the proposed Rottingdean tramway, but could not recommend the Council to waive its right to take over the railway under the terms of the lease.

The T.C. has resolved, by 29 votes to 15, to appeal against the judgement of Mr. Justice Grantham in the case of Macartney, McElroy & Co., Ltd., *v.* the Corporation, recently reported in these columns.

Burnley.—The working of the Corporation tramways during the past year shows a profit amounting to £3,536 8s. 10d., which is to be placed to the reserve fund. This fund now amounts to £6,749. There has been a considerable increase in the traffic during the year. The number of passengers carried was 7,514,063, against 6,131,050 in 1903, the car-miles run being 896,397.

Exeter.—In order to meet the demand for current for the electric tramways, additional plant is to be laid down at the generating station, at an estimated cost of £4,000. The new plant will include a 200-KW. steam tramway generator, a 200-KW. motor-generator or rotary transformer, and six switchboard panels.

Leeds.—The Tramways Committee is at present considering the split-turn system. An opportunity is to be given to the men to state their grievances against the system.

London.—Another extension of the London United Electric Tramways was opened on Tuesday, when Colonel Yorke, on behalf of the B. of T., inspected the new route from Hammersmith Broadway to Uxbridge. A special car was run from the depôt at Chiswick over the new line from Hammersmith Broadway through Askew Road to the Uxbridge Road, thence over the old line as far as Southall, and from that point over the latest extension to Uxbridge. On Wednesday morning a five-minute service of cars was to commence running from Uxbridge to Hammersmith and Shepherd's Bush alternately.

At the beginning of this week the L.C.C. section between Kennington and Water Lane, Brixton, which has been converted from cable to electric conduit traction, was opened for traffic. The work has been carried out by the contractors with most praiseworthy expedition.

Manchester.—Our correspondent writes:—"The general ineffectiveness of the lifeguards at present in use has received further illustration. The victims are young children in most cases. Last week the two-year-old child of an Ancoats labourer ran across the roadway in Every Street, just as a car was approaching. The motorman applied his brakes and reversed the power, but the child was struck by the corner of the fender, and the lifeguard failing to act, the wheels went over him. At the inquest a Corporation official stated that only the previous week the Board of Trade made a request that the 'gate and cradle' form of guard should be used on all cars. This is the type universally adopted in Manchester. In the case in question it apparently failed, and the explanation given was that when anything gets underneath the cradle is forced back automatically into its position. The authorities are, however, trying to devise a contrivance by which the cradle, at the moment of falling, will become locked automatically. The verdict was one of Accidental death."

Newcastle-on-Tyne.—A meeting of the T.C. was held on the 26th ult., to consider the joint report of the Parliamentary and Bye-laws and the Tramways Committees relative to the question of running powers between the Tyneside Tramways and Tramroads Co. and the Corporation. [The report of the Committees was given on p. 874 of our last issue.] Sir Charles Hamond, in moving the adoption of the report, said their future depended on the mode in which they acted, for they were to endeavour to make remunerative, if possible, a million and a quarter of the ratepayers' money. Referring to the first four clauses, Sir Charles said they would see that the only one serious point of difference between the company's proposals and their own, was in respect to the charge of 3½d. per car-mile run. He suggested that for the sake of unanimity they might omit that clause. That would make their course clear. He moved accordingly.—Alderman Newton said Sir Charles's suggestion as to the omission had been sprung on the Council, and he proposed that they should go into Committee to fully consider the matter. This was agreed to.—Mr. Cail objected to the omission of the 3½d. per car-mile. It was worth £1,500 a year to them.—Sir Charles said Mr. Cail was totally wrong. It only amounted to £300.—Mr. Morton and others said they understood from Mr. Rossignol that it meant £1,850.—Alderman Baxter Ellis seconded the confirming of the first four clauses, and eventually they were agreed to, including the proposal as to the 3½d. payment.—Mr. John Beattie moved that a through service be granted, and Dr. Adam Wilson seconded the suggestion, but it was negatived.—In regard to the third section the clauses relating to the Gosforth route, Sir Charles Hamond said the company seemed to aim at making money out of the Corporation, and when they did so they did not consider the convenience of the public. Eventually the report was carried as amended. The Parliamentary and Bye-laws and the Tramways Committees were associated to fight the Bill of the company. Sir Charles declared the inclusion of the Tramways Committee in the arrangement for fighting the Bill was a vote of censure on the Committee, and he tendered his resignation as chairman of the Parliamentary Committee.—The meeting ended, however, with cheers for Sir Charles. To summarise the position, it is only necessary to say that unless the company back down from their declared intention not to submit to the Committee alterations, the matter is precisely as it was weeks ago, and no alternative is left but fighting it out before Parliament.

Russia.—Electric traction is to be adopted on the Oranienbaum section of the Baltic Railway, the necessary approval of the Russian Minister of Ways and Communications having been secured.

Southport.—The Corporation has under consideration proposals from the Southport Tramway Co., Ltd., with a view to, if possible, entering into an agreement for the company leasing the Corporation lines, or the Corporation buying the company out. The company propose to take over the Corporation lines. At the same time they will take all the electric current they require on the conditions existing between the Corporation Tramways Committee, and the Corporation Electricity Committee. After payment of the rent, the company would be entitled to the payment of 5 per cent. on so much of their capital as has been expended in the borough of Southport, and this is put at £25,000. Of the balance, the company should be entitled to set up a depreciation fund not exceeding 4 per cent. per annum on one-half of the above amount, that is, on £12,500.

South Shields.—A meeting of the Tramways Committee was held on the 26th ult. to consider the replies of the South Shields Tramway and Carriage Co., Ltd., and of Messrs. Rowcliffe and Co., of Manchester, to the Committee's inquiry as to whether they would submit amended tenders for the construction, as well as the leasing of the new tramways, and it is understood that the firms agreed to do so in accordance with the conditions laid down by the Committee. To do so, the firms are to be allowed a further period of 28 days.

Spain.—Plans have been prepared in respect of a projected electric railway between Ejea and Zuera, a distance of 25 miles.

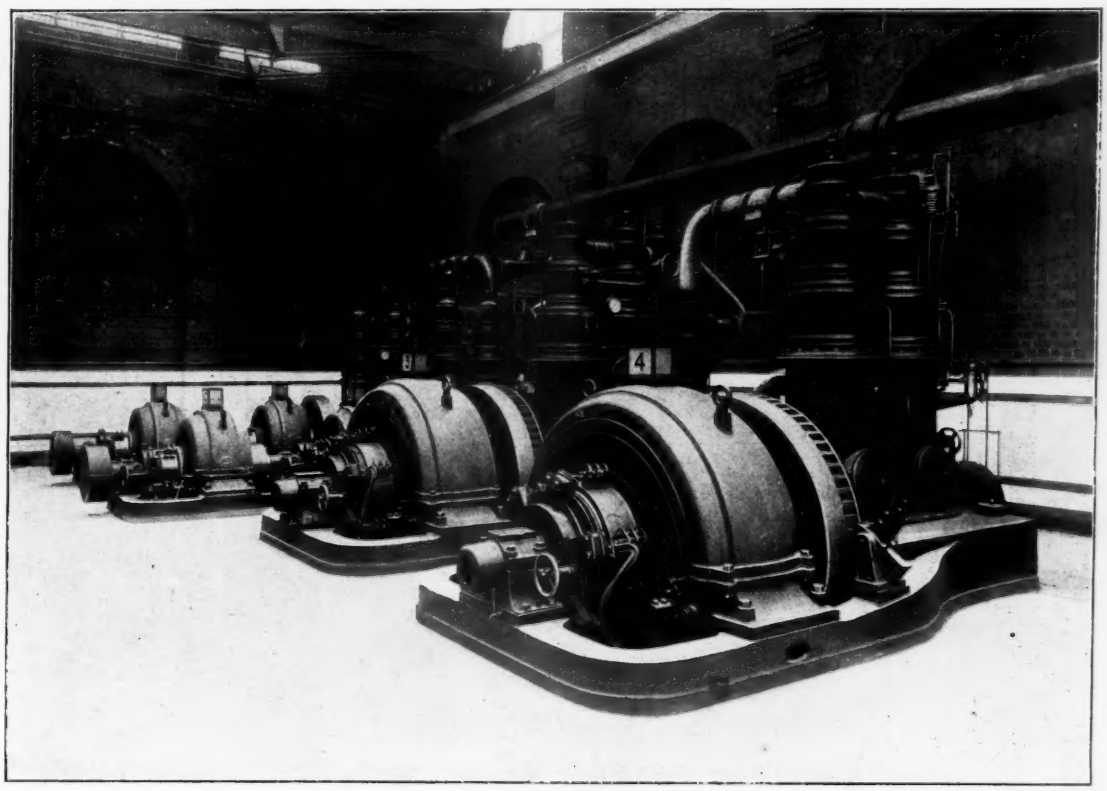
(*Continued on page* 920.)

KETTERING ELECTRICITY WORKS.

In a recent issue we reported the opening of the new electricity works of the Urban District Council of Kettering; we now give a brief description of the works themselves. The provisional order authorising their construction was obtained in 1896, but owing to the pressure of other undertakings the order was not put in force until the Board of Trade threatened its revocation. Dr. A. B. W. Kennedy was then appointed consulting engineer, and prepared designs and estimates for the electricity works, whilst the buildings were designed by the Council's surveyor, Mr. T. R. Smith. The sanction of the Local Government Board was obtained to a loan of £43,275 for the electricity works, including the site, and £5,100 for the refuse destructor which adjoins it, and the contracts were placed in July, 1903.

The site covers two acres of ground, and is fairly central, the main entrance being in Rockingham Road. The building is of brick, and the design is of more than ordinary merit. The interior is well lighted from the sides and roof, the latter being provided with a ventilating lantern, and consisting of glass and slate, with matchboarding under the slate. The ventilating louvres are of zinc, and are so shaped as to effectually exclude rain and spray, whilst allowing free passage to the air. Besides the engine and boiler houses, there are offices for the chief and assistant engineers, and for the clerical staff, stores, meter room, drawing office, battery room, &c., adjoining the main entrance, and the refuse destructor is situated close to the boiler house. A large space is left for additional plant in the engine room and boiler house, as shown in the plan, p. 919.

The boiler house is sunk below the level of the engine-room floor, and is provided with a series of open bunkers opposite the front of the boilers, into which coal can be directly tipped from carts on the higher ground level outside. This side of the boiler house is roofed with galvanised iron, and can be closed with roller screens when necessary. The steam-raising plant at present installed, consists of four Lancashire boilers, supplied by Messrs. Edwin Danks & Co. (Oldbury), Ltd., each 28 ft. long and 8 ft. in diameter; three of these are in the boiler house, the fourth being in the destructor house. The former are fitted with balanced fire doors, and Dewrance's fittings. A duplicate service of feed-water piping is provided, with by-passes to the economiser, &c., in connection with two "4-inch" feed pumps supplied by Messrs. G. & J. Weir, which supply the boilers through a 4-in. Kennedy meter from an overhead tank in the boiler house.



General View of Willans-Parker Generating Plant.

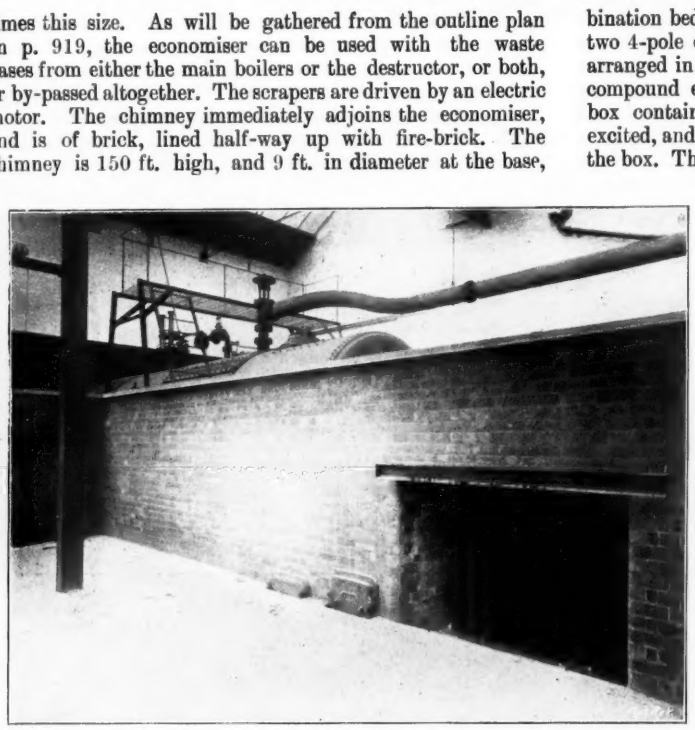
The overhead storage tank measures 14 ft. × 8 ft. × 8 ft. deep, and is filled from the town water mains. Each of the pumps is capable of delivering 3,500 gallons of water per hour.

The steam piping forms a complete ring, of which one limb is in the engine room and the other in the boiler house; the latter limb is connected at one end with a pipe from the boiler in the destructor house.

The only difference between the boiler last mentioned and the other three is that it is designed for a higher steam pressure—200 lbs. per sq. in.—and, of course, has no internal furnaces. A separate Weir feed-pump, of the 2-in. size, and a water meter are provided in the destructor boiler house.

Outside the main building is the economiser, which consists at present of 192 tubes, but will eventually be three

times this size. As will be gathered from the outline plan on p. 919, the economiser can be used with the waste gases from either the main boilers or the destructor, or both, or by-passed altogether. The scrapers are driven by an electric motor. The chimney immediately adjoins the economiser, and is of brick, lined half-way up with fire-brick. The chimney is 150 ft. high, and 9 ft. in diameter at the base,



Destructor Boiler House, Showing Economiser.

above the square pedestal. A 20-in. exhaust pipe is carried up the centre of the shaft to the top.

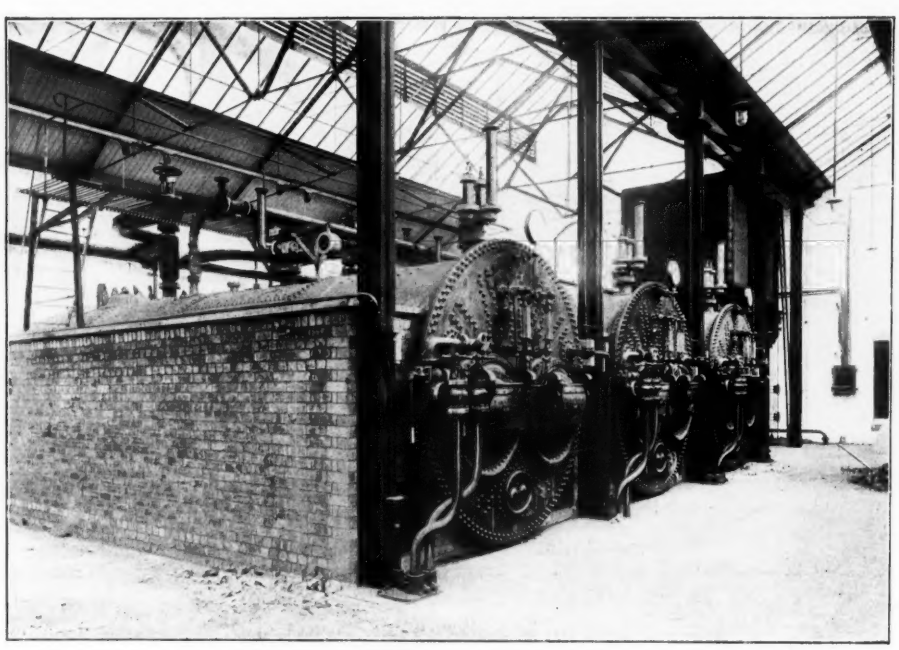
The destructor was built by Messrs. Meldrum Bros., and consists of two cells, with a separate combustion chamber as usual, and a large door at one end for the introduction of large articles, such as mattresses, &c. The gases pass from the combustion chamber either directly into the boiler flues or through a by-pass flue. Refuse is deposited from an overhead tipping floor on a platform, whence it is charged by hand into the furnaces opposite. A special feature of the plant is the hot-air supply to the furnaces obtained by inserting in the course of the waste gases the heat economiser shown in one of our views. The gases pass from the boiler flues down the set of iron pipes, which are placed in the air duct, as illustrated. The air thus heated is drawn past the pipes and delivered to the destructor furnaces by steam blowers.

The steam from the destructor boiler passes to the main steam range through a reducing valve made by Messrs. David Auld & Sons, and a non-return valve made by Messrs. Cockburn, Ltd., of Glasgow.

In the engine room there are at present installed the following sets of plant, all the dynamos being made by Messrs. Thomas Parker, Ltd., of Wolverhampton, and the engines by Messrs. Willans & Robinson, Ltd. :—Two 6-pole dynamos rated at 323 amperes, 460 to 520 volts, driven at 350 r.p.m. by 2-crank compound engines mounted on combination bedplates ; and two balancer sets, each comprising two 4-pole dynamos rated at 156 amperes, 230 to 260 volts, arranged in tandem, and driven at 450 r.p.m. by 2-crank compound engines. On each dynamo is mounted a signal box containing lamps, which light up when the machine is excited, and illuminate a number painted on the glass front of the box. The balancer armature shafts are provided with flanges at both ends, so as to be interchangeable.

There are also two reversible booster sets, supplied by the Lancashire Dynamo and Motor Co., and running at 850 r.p.m. ; each set consists of a 4-pole dynamo rated at 133 amperes, 90 volts, coupled to a motor of similar type. One of the motors drives, in addition, a small milking booster. The engine room is traversed by an overhead crane capable of lifting 8 tons, built by Messrs. Carrick & Ritchie. The switchboard presents an unusual appearance, owing to the manner in which 12 pivoted voltmeters are mounted above it. The main board was supplied by Messrs. Cox-Walkers, Ltd., of Darlington, with Eversheds & Vignoles instruments, and is mounted on a raised platform along the side of the engine room remote from the boiler house. The board consists of 15 panels of enamelled slate, carried by an iron frame. The generator panels are on the left, the feeder panels on the right, and the auxiliary apparatus is controlled on the middle panels. There are six generator panels, each fitted with an ammeter, two circuit-breakers, plug bars, voltmeter coupler, and double-pole change-over links. The plug bars are used in connection with two sets of main bus-bars behind the board; the change-over links are provided for changing from self-excitation to battery excitation by means of auxiliary excitation bus-bars.

The next three panels are allotted respectively to the motor and generator of one booster, and to the positive battery. The motor panel is fitted with a starter, centre-zero ammeter, two plug bars, voltmeter coupler, and D.P. switch ; the generator panel with two circuit-breakers, centre-zero ammeter, two plug bars, shunt break switch and voltmeter coupler; the battery panel with a circuit-breaker, disconnecting switch, centre-zero ammeter, one plug bar, bus-bar coupling switch, and voltmeter coupler. These three panels are repeated in reverse order for the negative battery and booster set, with no material difference.



Main Boilers.

The next panel carries the mid-wire, earth connection, and milking booster ammeters, all of the centre-zero type, a D.P. switch and field switch for the milking booster, voltmeter coupler, and two feeder pilot voltmeter switches.

Lastly, there are two feeder panels, providing for four feeders, each equipped with four main switches, shunted by small fuses, and four ammeters. The object of the shunt fuses is merely to prevent burning of the switch contacts in case of breaking a heavy load ; there are no fuses in circuit with the feeders at the power station.

The regulating rheostats for the generators are fixed along the front of the switchboard platform, and are of the slide-bar type.

We may here mention that the batteries are operated *en bloc*, the boosters being practically at all times in use, either to charge or discharge the batteries as required. The reversal of the boosters is accomplished by means of the field rheostats, and they can, if necessary, be used in five different ways, in connection with the batteries and the feeders. The feeder connections on the back of the board are made by means of short flexible cables, so that they can be readily changed from one set of bus-bars to the other, if desired, in order to run at different station pressures. The positive conductors are carried overhead to the board, while the negatives come up from below.

Behind the board are mounted, on the wall, meters of the Electrical Co.'s type in circuit with the dynamos and motors, and separate charge and discharge ampere-hour meters of Messrs. Chamberlain & Hookham's make in connection with the batteries, together with Elliott recording ammeters. All the dynamos and motors are also provided with fuses on the wall behind the board.

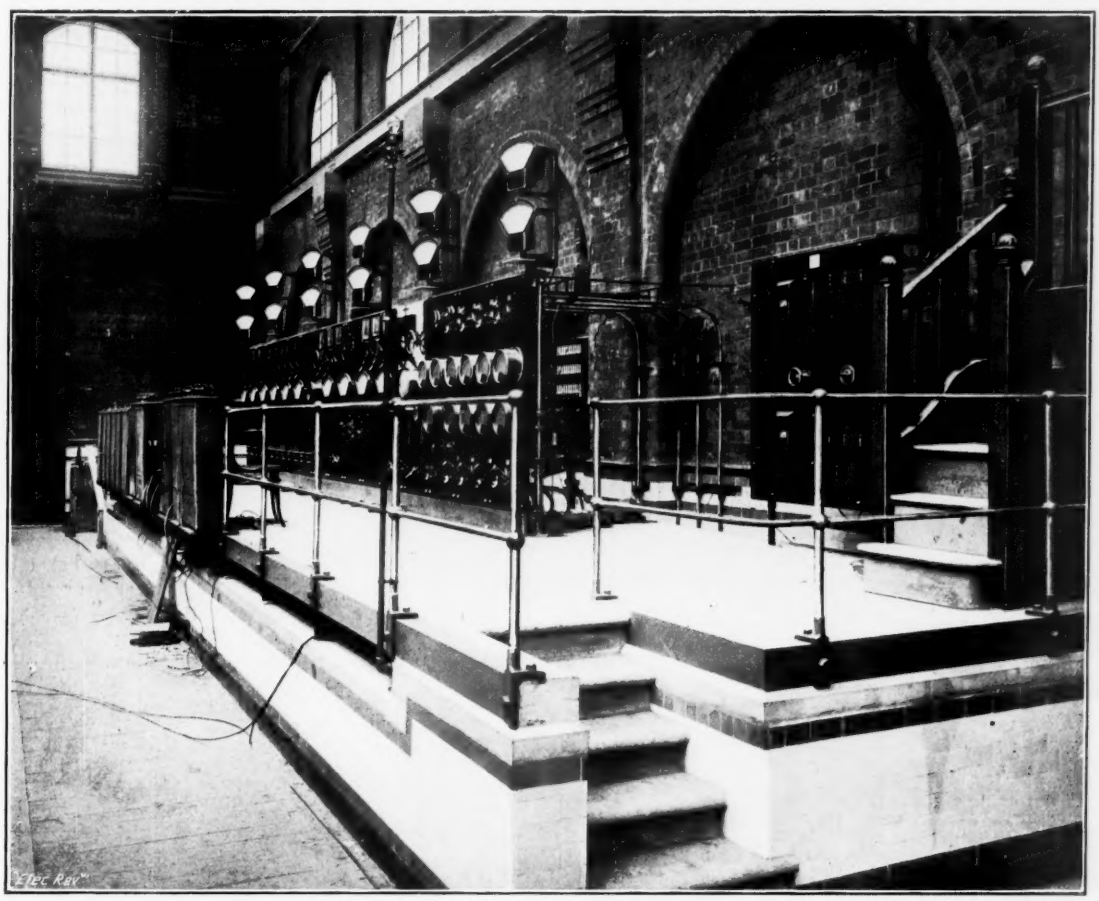
The middle wire is dead earthed through a recording ammeter in circuit with a cut-out, which, when the earth current exceeds 20 amperes, throws a resistance in circuit, rings a bell, and lights a lamp. The mid-wire is also earthed through an ammeter, switch and fuse. A 36-way fuseboard is fixed on the wall to receive the terminals of the pilot wires from all the feeding points in the town.

A station lighting and power board, supplied by Messrs. Lea and Warren, of Kettering, is fixed near the main board, and carries three two-way D.P. switches, three S.P. switches and a number of fuses, two Aron meters, and two Ward-Leonard rheostats used for regulating the voltage for the station lighting.

The work in the basement below the switchboard is of special interest. As shown in our view (p. 918), it consists entirely of bare copper rods carried on porcelain insulators fixed to an iron frame. This system is carried out from the generators and motors to the switchboard, and makes an excellent piece of work, practically fireproof and indestructible.

The batteries are housed in a room adjoining the engine room, and consist of 120 cells each, of the Electrical Power Storage Co.'s make. Each cell consists of 13 plates of 360 ampere-hours' capacity, in a leaden box carried in a cast lead strengthening frame, and stands on glass oil insulators on wooden battens. The latter in turn are supported on porcelain oil insulators.

The mode of working the battery which we have described—



Main Switchboard.

i.e., without end cell regulating switches—is one which we have advocated for several years ; its advantages are now generally recognised, and the costly and cumbersome arrangement of conductors formerly met with in battery rooms is conspicuous by its absence.

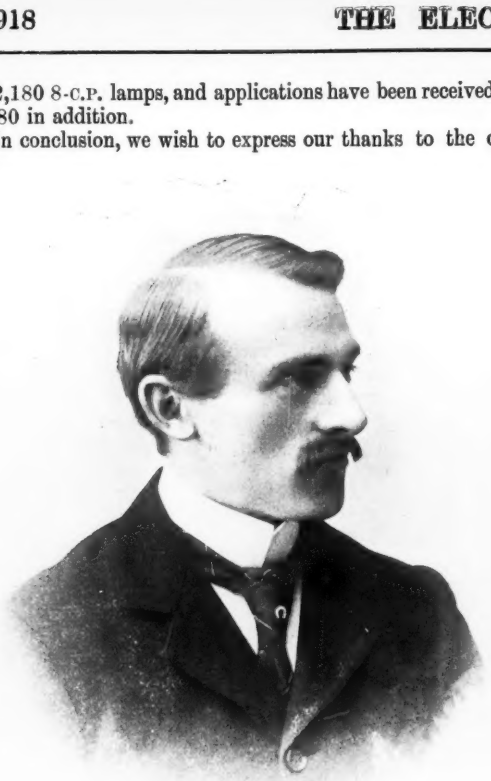
The network in the town is fed by means of four feeders, each consisting of a paper-insulated lead-covered concentric cable having a cross-section of 0·3 sq. in. per conductor, made by Messrs. W. T. Glover & Co., Ltd., of Salford. A single 0·25-in. mid-wire feeder is taken from the station to a disconnecting box in the town.

The streets are lighted with arc lamps, supplied by the Gilbert Arc Lamp Co., of Chingford, there being three circuits of 10 arcs each ; these are replaced by glow lamps at 11 p.m., the latter being controlled quite independently of the arc lamp circuits. "Westminster" arc lamps are used for the station lighting.

The prices charged for energy are very low—4½d. per unit for lighting, and 2d. to 1½d. for heating and power. The connection already obtained amounts to the equivalent

of 2,180 8-c.p. lamps, and applications have been received for 1,380 in addition.

In conclusion, we wish to express our thanks to the consulting engineer, Dr. A. B. W. Kennedy, and to the electrical engineer to the U.D.C., Mr. F. J. Bakewell, for their kind assistance in the preparation of this article.



Mr. F. J. Bakewell, A.M.I.E.E., Electrical Engineer to the Kettering U.D.C.

ATAVISM.

The theory of cyclical evolution is as yet accepted only as an explanation of exceptional phenomena, and not as a principle to be universally applied. It may, possibly, be looked upon as the exception which proves the rule of progressive evolution.

When, in a stable of thoroughbreds, a foal appears bearing stripes and markings similar to those of the zebra, or when a young blue rock pigeon is hatched out from an egg of the highly-developed fantail, one puts it down to "atavism," or "reversion." The phenomenon serves to remind the parents of their humble origin, and tends to check too great a conceit of blue blood.

Nor is it always necessary to wait for a succeeding generation to produce the characteristic features of "atavism." Instances are not uncommon in which an adult assumes a form representative of a lower type than the young of the same order.

Laying Glover Mains at Kettering.

Touching even human life, we are familiar with the terms "dotage" and "second childhood;" a man in old age often reverts to the habits of infancy. And, coming nearer home, a technical author, who, in his prime, occupies a position in the front rank, may in later years write things that have in them a suggestion of retrogression, either of thought or of style.

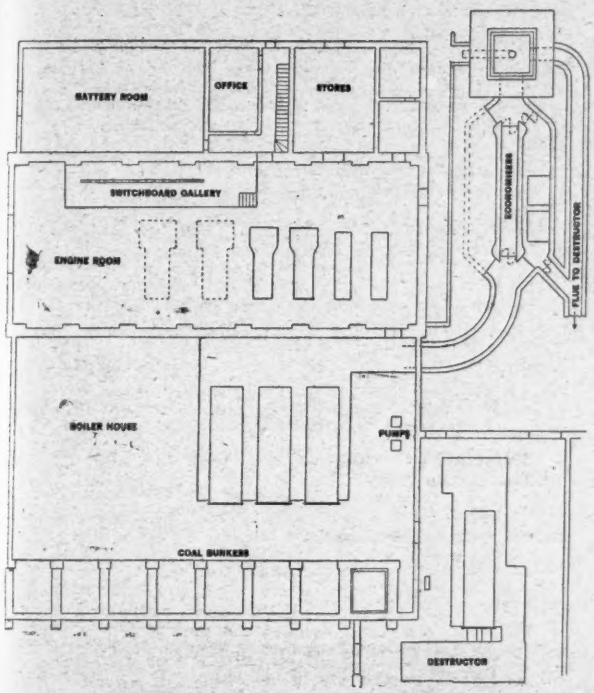
In electrical apparatus, too, this tendency to revert to an earlier type is occasionally met with. The earliest type of electric switch was of the simple "chopper" or "knife" pattern, gradually displaced by the "rotary" type which,

Kettering Electricity Works: Bare Copper Connections in Basement.

during about 10 years, passed through various stages of evolution, reverting again to the "tumbler" or "chopper" type now almost universally used.

If, then, we must admit "reversion," or "atavism," in such details as switches, why not in systems such as artificial lighting itself? Are there not signs of it already? From the torch of pre-historic times we have evolved through the candle, flare lamp, and gas ages to the age of electric lighting. The lucigen torch, the gas flare, and the electric candle fitting serve to remind us that the transition period is not yet complete, nor it seems are we destined to witness this ardently desired consummation, for now a well-known expert, Mr. W. H. Booth, tells us, in all seriousness, that electric lighting is already practically doomed.

"At this moment electric lighting stands where it did when first commercially introduced. There has been practically no progress." Thus Mr. Booth in *Cassier's Magazine*. Nor is this all. The electrical engineer must drain the bitter cup to its very dregs. Not enough that electric lighting has made no progress, but "gas lighting



PLAN OF KETTERING ELECTRICITY WORKS.

with modern methods is at present far ahead of electricity in all save convenience, and, under ordinary circumstances, health." Surely there is some hope here; health, at least, is a vital consideration.

No! Not even this consolation is left to us, for, our iconoclastic critic proceeds: "The economy in one year over electricity would pay for the ventilation necessary to remove the products of combustion." So that, although for special situations "for which gas is out of the question," electricity may still have a faint chance of success, "for plain, straightforward lighting of rooms, workshops, and public buildings, it appears very doubtful whether electricity will continue to hold its own in any sense of the term." One looks in vain for a redeeming feature. A glimmer of hope is given when the author says "for 100 years, little or no improvement had been made in the methods of using gas." A hundred years seems a long time to stand still, but, instead of looking upon this as a hopeful sign for electric lighting, Mr. Booth apparently considers it an argument for the inherent virtues of gas lighting, in that it could survive this period of stagnation, and then, "due to the stimulus of electric light," develop into the cheapest and most efficient form of artificial illumination. No crumb of comfort is forthcoming for the electrical engineer. The tantalising taunt "serves you right, I told you so," appears to stare at you from the pages as you read these lines, "The machinery of electric light has become more complicated instead of simpler as time has moved on. Electric light engineers appear to have succumbed to this tendency without an effort, and their undertakings have been burdened with this load of complications as well as a load of duplicate plant, made necessary by the hand-to-mouth methods which are still practically compulsory in the absence of a satisfactory system of storage."

What a scathing impeachment! The more scathing coming from so unquestioned and unquestionable an authority. 'Twere vain to dispute the facts as here presented by so gifted an author. The words quoted have a truly prophetic ring about them, the final impression left in the mind of the reader being somewhat of this order:—

Woe unto you, ye workers in electricity, ye lovers of darkness, degenerates! who have forsaken the simple methods of your fathers, and have set up in your power houses complicated and burdensome systems, and have bowed down to them and worshipped them. Ye have loaded your stations with strange devices, which are abominations, living from hand to mouth, and storing none of your produce against the evil day.

Behold, therefore, it shall come to pass that the sun shall be darkened at noonday, and your light shall utterly fail; yea, it shall be completely cut off for ever. The hum of your alternators shall be turned into groanings, your feasts into mourning; it shall be as the mourning of an only son, and the end thereof as a bitter day. Howl, therefore, woe worth the while!

It is an unpleasant prospect which faces us if our prophet should be honoured in his own country—and there are signs, unmistakable signs, of retrogression to justify his dark forebodings. Only a few days ago, in the columns of a leading contemporary technical journal, a description was given of some new electrical candle fittings, the design of which it was said "is the nearest approach to real candle lighting in appearance ever placed on the market."

And what is the cause of this impending doom of electric lighting, one might ask. Two causes are given: one the cost, and the other, the inefficiency as compared with gas light. "In coal consumption the incandescent electric light probably demands three times as much as modern gas lighting." "With the Welsbach light, gas at 3s. is equal to electricity at 1d. per unit. With other gas systems the cost of electricity must come down to a still lower figure, and this at present seems to be beyond the range of visible possibilities." An unsolicited testimonial such as this, is worth a great deal to the Welsbach Co., and our prophet shows something of the wisdom of the serpent in thus early "making friends with the mammon of unrighteousness."

But if "cost and efficiency," reduced to terms of milligrammes of coal per candle-power, are to be the sole considerations in judging of the prospects of continuity of any system of lighting, what are we to say of other modern systems which, on analogous bases, show to like disadvantage, admitting for the moment the accuracy of the above statement?

What, for example, will become of our electric railways and other power systems? One of the cheapest journeys on an electric railway is that from the Bank to the Bush by "tube." The price, 2d., is less than one-third of the actual cost to the railway company; yet how often in the old days has one walked the full distance at 2d. less than this extraordinarily low fare—that is to say, at about 6½d. less than it costs the company to carry a passenger right through. Clearly, therefore, on the question of cost alone, the "tube" must go. And what about efficiency? To walk the distance comfortably takes 1½ hours, or, reckoned in energy, it requires an expenditure of, say, 1½ man-power-hours. The energy necessary to carry a passenger the full distance on the "tube" is 1·6 units, or approximately *2 horse-power-hours*. Reckoning 1 H.P. as the equivalent of 10 man-power, it takes about 13 times as much energy to carry a man from the Bank to the Bush by the "twopenny tube" as it does for the man to carry himself. True, the "tube" does the journey in 20 minutes, but it takes an average of 6 H.P. per passenger all the time, whereas a coolie could run one down in a rickshaw in about half an hour or so.

Weighed in the balance, therefore, the "tube" is found wanting, both on considerations of cost and efficiency. The theory that the smooth travelling on electric railways conduces to appendicitis is another nail in the electric coffin.

From electric light to gas and from gas to candle-light (and why stop at candles, since daylight costs nothing); from electric railways back to rickshaws, from rickshaws to walking (and why walk, since standing still is more economical) what could be more reversionary or atavistic! Even the food we eat is costly and inefficient, and the air we breathe—but, really, if we begin to inquire too minutely into everything, from this point of view, we shall end by saying in the words of the song, "Wot's the good of ennyfink?—Why, nuffink!" F. B.

TRAMWAY AND RAILWAY NOTES.

(*Continued from page* 914.)

Sunderland.—The annual report of the Corporation tramways for the year ending March 31st, 1904, has been issued by Mr. A. R. Dayson, the general manager. It mentions that the most important items in the past year have been the construction and opening of the east-end trams, the opening of the Hylton Road depôt and repairing shops, and the commencement of the construction of the new tramways offices. Of these works details are given. Coming to figures the report states that the wretched weather last summer militated against the traffic receipts. The increase in miles run, passengers carried, and receipts, is not so great as they could have wished, but the increase is, on the whole, satisfactory.

Year.	Receipts.	Passengers carried.	Car-miles run
1903	£59,142	13,987,121	1,270,957
1904	£62,506	14,848,958	1,433,463

The above figures show an increase of passengers of 861,837, and an increase in receipts of £3,364. An analysis of the traffic receipts for the different routes shows averages of £170 15s. 8d. per day, £3 6s. 11½d. per car per day, and 10·46d. per car-mile. The income was £62,507 from traffic receipts, and other items bring up the total to £63,067. The working expenses were £36,318, and interest, sinking fund and depreciation absorb £22,329 = £58,647, leaving a balance of £4,420. The figures show an income of 10·55d. per car-mile, working expenses 6·08d. per car-mile, interest, sinking fund and depreciation fund 3·73d., making a total expense per car-mile of 9·81d., leaving a net profit of ·74d. The percentage of gross profits on capital expended is 9·65, and the percentage of net profits on capital expended, 1·59.

TELEGRAPH AND TELEPHONE NOTES.

The German Atlantic Cables.—A cable has reached us just as we are going to press, stating that the duplicate cable section between Azores and New York was completed on Wednesday night, giving the Deutsche Atlantische Telegraphengesellschaft two direct routes between Germany and New York.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1903	
St. Lucia-Martinique	May 7, 1903	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Cayenne-Pinheiro	Aug. 18, 1902	
Anjer-Kalianda	Aug. 2, 1903	
Reissa-Issa (Yemen)-Camaran	Oct. 29, 1903	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Nagasaki-Vladivostock	Feb. 16, 1904	
Closed { Port Arthur-Chefu	Feb. 18, 1904	
Foochow-Formosa	Feb. 11, 1904	
Gibraltar-Tangier	May 17, 1904	
Landlines.		
Seoul-Massmpo	Feb. 13, 1904	
Seoul-Gensan	Feb. 13, 1904	
Anju-Ping-Yang	Feb. 25, 1904	
Ninguta-Vladivostock	March 2, 1904	
Dominican lines	May 26, 1904	

Wireless Telegraphy.—Reuter's agent at Rome reports that the Marconi wireless telegraph stations at Bari and Antivari (Montenegro) have now been erected for a month, and are in regular working order. Signor Marconi will personally open them in July next on his return to Italy. The high power station at Coltano (Pisa), near the Royal farm of San Rossore, will be the largest in the world, and will be built entirely of stone. It will be ready in August or September, after which the engines and other apparatus will be installed, so that it may begin working not later than the beginning of 1905. The Coltano station will be able to communicate with Great Britain, Canada, the United States, and the Netherlands, as well as with all vessels in the Mediterranean, the Baltic, the Red Sea, the Atlantic Ocean, and the Indian Ocean. Signor Marconi has signed contracts with Chile and Argentina to construct telegraph stations.

The New York correspondent of the *Times* says that a circumstantial statement from Washington that the Government intends to control, and, perhaps, acquire, all wireless coast stations is circumstantially denied on high, perhaps the highest, authority. "The thing is not possible, says a Navy Department official, without impossible action by the Courts, the Legislature, and the Executive. What is contemplated is, in the first place, merely some consolidation of the existing services of the different departments for the better administration of all; and, secondly, the probability that the Government, in time of war, may insist on exclusive rights."

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—The Municipal Authorities are about to invite tenders for the establishment of a large central electric lighting station in the town.

Cheshire.—Electric light plant, wiring and fittings, for Parkside Asylum new infirmary annexe. See "Official Notices" May 27th.

Chili.—June 28th. Electric lighting of the city of Punta Arenas (Straits of Magellan). See this column for February 19th.

Colchester.—June 13th. Electric lighting installation at the car depôt. See "Official Notices" to-day.

Deptford.—June 21st. Two 25-KW. steam dynamos, booster and switchboard, for the electric lighting of the new Town Hall. See "Official Notices" May 27th.

Edinburgh.—June 4th. Copper strip for electric conductors. See "Official Notices" May 27th.

Exeter.—June 9th. Permanent way, overhead equipment, cables and cars. See "Official Notices" May 13th.

Germany.—June 15th. Tenders are being invited until June 15th by the Prussian State Railway Authorities at Bromberg for the supply and erection of an electrically-operated locomotive turn-table. Tenders are to be sent to Die Königl. Eisenbahn, Direction, Bromberg, whence particulars may be obtained.

Handsworth.—June 8th. Erection of generating station. See "Official Notices" May 20th.

Johannesburg.—July 4th. Cables, conductors, and accessories. See "Official Notices" May 13th.

Leigh.—June 21st. One 350-KW. steam-driven set and switchboards. See "Official Notices" to-day.

May-Oatway Installations.—Tenders are invited for further installations on this system at Govan and Leith. See "Official Notices" to-day.

Pontypridd.—June 4th. Motors. See "Official Notices" May 13th.

Portsmouth.—June 11th. Pump and piping. See "Official Notices" May 27th.

Shanghai.—July 30th. The Municipal Council invites tenders for a 24-mile electric trolley line concession. Particulars from J. Pook & Co., 63, Leadenhall Street, E.C., the London agents of the Council. See "Official Notices" May 13th.

Spain.—July 15th. The Spanish Ministry of Public Works in Madrid is inviting tenders until July 15th for the concession for the construction and working of an electric tramway between Sarria to the foot of Vallvidrera mountain (province of Barcelona). Tenders are to be sent to El Ministerio de Obras Publicas, Madrid, whence particulars may be obtained.

Stepney.—June 20th. Electric light installation at the Public Baths. See "Official Notices" May 27th.

Uphall.—June 10th. The Bathgate District Committee of the County Council of Linlithgow invites tenders for fitting up an electric light installation for the lighting of the Uphall Lighting District. Specifications, &c., at the office of the Committee's engineer, Mr. Alexander Lindsay, 11, Jamaica Street, Glasgow.

Wimbledon.—June 17th. Water-tube boilers, economisers, feed pump and pipework. See "Official Notices" to-day.

CLOSED.

Bristol.—The Corporation has placed an order with Messrs. Bruce Peebles & Co., Ltd., for the supply of a 400-KW. generator.

Chatham Dockyard.—Messrs. Isaac Storey & Sons, Ltd., of Manchester, have received through Messrs. Bruce Peebles & Co. an order for six sets of surface condensing plant in connection with their Chatham Dockyard contract.

Derby.—The Tramways Committee has accepted the tender of Messrs. Newton Bros. for the wiring of the car-sheds, at £193.

Dundee.—The following is a list of successful contractors for engineering stores:—Messrs. George Stephen & Son; Messrs. Robert Stiven & Co.; Messrs. R. C. Stiven & Sons; Mr. C. D. Braid; Messrs. Kirk & Coutts; Messrs. Robert Fergusson & Sons, all of Dundee. For electrical goods:—The Edison & Swan United Electric Light Co.; Messrs. Ward & Goldstone, London; the Sir Hiram Maxim Electrical Co., Manchester; the Union Cable Co. For piping:—Messrs. Stewart & Menzies, Ltd., Glasgow.

Gloucester.—The T.C. has accepted the tender of the Municipal Appliances Co., Ltd., for a sand dryer for the tramways, at £40.

Hull.—The Corporation Telephone Committee on Friday accepted the tender of Messrs. Collier Bros., of Manchester, for the supply of copper wire at £570 8s. 10d.

Kilmarnock.—The T.C. has accepted the offer of Messrs. Dick, Kerr & Co., amounting to £22,784, for the permanent way construction in connection with the electric tramway system.

Loughborough and Canterbury.—Messrs. Pritchetts and Gold, Ltd., have received an order from the Loughborough Corporation for a 260-cell storage battery for electric lighting purposes. They have also received the contract from Canterbury Corporation for replating a 232-cell battery.

Sunderland.—It is stated that the Electricity Committee has accepted the tender of a German firm for three-phase cables, it being considerably lower than any British quotation sent in.

Twickenham.—The U.D.C. has accepted the tender of Messrs. Meldrum Bros., Ltd., of Manchester, for the supply of refuse destructors, at £2,650.

FORTHCOMING EVENTS.

Friday, June 3rd.—At 9 p.m. Royal Institution. Prof. Svante Arrhenius on "The Development of the Theory of Electrolytic Dissociation."
Monday, June 6th.—At 7.30 p.m. Society of Engineers. Meeting.
Thursday, June 9th.—At 5 p.m. Institution of Electrical Engineers. Annual general meeting at 92, Victoria St., S.W.
At 8 p.m. The Faraday Society. "The Electric Furnace: Its Origin, Transformations and Applications," by Mr. Adolphe Minet. "The Hard and Soft States in Metals," by Mr. G. T. Beilby.
Friday, June 10th.—At 8 p.m. Physical Society. Meeting.

NOTES.

Organisation of Technical Employés.—A correspondent writes:—"No fewer than 2,000 engineers, technical men, chemists, &c., of all callings and degrees of ability, from engineer with diploma and academical training, and from fully qualified chemists to draughtsmen, have combined for the purpose of forming a large, far-reaching organisation for themselves, as industrial workers. It is a trades organisation, under the name of the "Bund der Industriellen Beamten (Arbeitrohmerbund) (Union of Technical Employés), located in Berlin, for the purpose of counteracting any further prejudice of condition of technical workers in industrial life. Our union will not be a club, but an organisation, without any political features, though with a strongly-marked economical tendency. Our programme for re-habilitation of the technical employés question is, alas, very large. Through most open activity and the strength of this union, we shall strive to assure, also, for ourselves, that protection which has been granted to every workman by his employers and the Government. In the first place, it is our duty to provide for a central employment bureau and a fund for the support of needy members, who are out of employment through no fault of their own. In carrying out our difficult project, we are counting on the assistance of the whole of the Press, which, up to the present, has remained silent, as well as on the active co-operation of all employers, who take an interest in the welfare of their employés; but, before all, on the complete co-operation of all our colleagues, who are, like us, of the conviction that the time has now arrived when we must do something to help ourselves in order not to endanger our social existence still further. The place of business in Berlin, W. Tobedemustrass, 70A, receives names, and also gives necessary information."

Steam Pipe Coverings.—A Mr. Davies, of Bradford, has elaborated a system of testing steam-pipe coverings, consisting of a vessel with a cold water jacket. Inside this is a piece of steam pipe, 2 ft. long, covered with the composition to be tested. This tube contains an electric heater in paraffin wax. Current is passed to maintain the wax at a constant temperature, and the amount of current required measures the heat lost through the covering.

Twenty-three kinds of covering were tried, and the tests generally did not show that asbestos was a very high-class article. Magnesia and slag wools came much higher up. About the best substance is waste silk, which retains 80 per cent. of the heat that would pass a bare pipe. Of course, it does not follow that any organic substance should be used for superheated steam, unless first shielded by some mineral cover and an air space.

Appointments Vacant.—Charge engineer for York (£100); electrical draughtsman for the Metropolitan Asylums Board; instructors wanted for the engineering and electrical engineering department at Northampton Institute.

The Largest Organ.—The greatest pipe organ in the world, built by the Harris Organ Co., of Los Angeles, California, under the patents of Mr. W. B. Fleming, and intended for the Convention Hall, Kansas City, is temporarily installed in the Festival Hall of the St. Louis Exhibition, where it will be played by some of the most famous organists and "acres of automatic music." It is as large as a "brick block," being about 100 ft. long × 40 ft. high and 27½ ft. broad. It weighs 125 tons, has 10,059 pipes, 289 movements, 140 stops, and cost about $100,000. Two electric motors, each of 10 H.P., drive this "factory of sound," which required for its construction 100,000 ft. of timber and 115 miles of wire. The metal pipes took 16,000 lbs. of zinc and 9,000 lbs. of soft metal. The wooden pipes contain 3,500 ft. of sugar pine. The two pipes of lowest tone are each 32 ft. long, and a couple of men abreast, or a small pony, can walk through them. The longest metal pipe is 37 ft. long × 17 in. in diameter. A train of 10 cars brought the organ from California to St. Louis. Its expressive powers are beyond those of any other organ, and comprise all the instruments of a full band. The only other organ approaching it is that of the Town Hall, Sydney, N.S.W. The new organ combines five organs, namely, a grand organ, a choir organ, a swell organ, a solo organ and an echo organ, which is independent, having its own bellows, and is removed 300 ft. from the rest. All five organs can be played automatically at the same time by a separate key desk of oak, provided with a self-performing apparatus. A second movable key desk or console, connected to the organ by an electric cable 150 ft. long, serves for the organist, who must be able to command five manuals or key boards in tiers, containing 61 notes. A full orchestration would call for 10 fingers on each hand, but, by means of a "double touch" applied to the manuals of the swell and choir organs, an additional pressure on the keys adds the voices of any stops drawn from the expressive division of the organ to any note, or group of notes, under the fingers or automatic player, and magnifies the wave of music. There are five bellows, each 12 ft. long × 6 ft. wide, and worked by two 10-H.P. electric motors. They are driven from accumulators fed by a dynamo, and the power of the batteries can be seen on instruments at all times. The driving mechanism is so planned that a continuous performance of the organ can go on during the Exhibition. The swell organ gives, for the first time, the true orchestral element, namely, the flutes, piccolo, clarinet, oboe, the corni, horn, and violin, as well as the human voice (*vox humana*). Another division of the "swell" is likewise a novelty. It contains 1,281 pipes, mostly of pure tin, each giving a string tone. The solo organ represents the brass wind instruments. Both the key and the draw stop actions are accomplished by means of electro-magnets, to the number of 1,300.

The B.A. Meeting for 1906.—There is a movement on foot in York towards asking the British Association for the Advancement of Science to hold its 1906 meeting in that city.

Experiments on the Emanation from Radium Bromide.—In order to show the diffusion of the emanation from radium bromide, a long tube has been used, the internal surface of which was coated with a layer of zinc sulphide, when on connecting the apparatus with a test tube containing a solution of radium bromide, a luminescence was found to appear and to be propagated throughout the tube. On repeating Ramsey's experiments, Th. Indricson (see paper read before the Russian Physico-Chem. Society), found the yellow helium line not to coincide with the yellow line of the spectrum given by the emanation, but to lie between the two yellow lines of the emanation. On the serpentine communicating with the tube being dipped into liquefied air, a strengthening of the lines corresponding to the helium line was noted in the spectrum of the emanation, while between the two yellow lines above referred to, a third line coinciding with the yellow line of helium would appear. The lines of helium do not exist in the spectrum given by the emanation of a freshly-prepared tube, but appear only afterwards. On observing the gases set free on the dissolution of radium bromide, it was observed that the helium lines did not appear as long as the spectrum tube preserved its phosphorescence in the dark. After four days, this phosphorescence would disappear, while the lines of helium were then noted in the spectrum.

Egypt.—According to the *Egyptian Gazette*, the Fayoum Municipality has agreed with Mr. Clowes, the Inspector of the Fourth Irrigation Circle, to utilise the Nazleh waterfall for the purpose of generating electricity for the lighting of Medivet-el-Fayoum. "But," says our contemporary, "800 H.P., which will be the power produced, is more than is necessary to provide sufficient electricity to light the Fayoum, and the rest of the available power might be used for other purposes, such as cotton manufacture, corn mills, &c. This presents a splendid opportunity for any syndicate or capitalist to step in and make some arrangements with the municipality."

The plant for the electric lighting of the town of Suez has reached its destination, and when the mail left wooden poles were being erected in the various streets. It is expected that the installation will be completed by the end of August.

Action of Radium on Glass, Quartz and other Bodies.—Glass is blackened under the influence of radium rays, and the same phenomenon is observed in the case of quartz. The colouration produced by radium disappears not only under the influence of heating, but also at ordinary temperatures. N. Georgiewski, in a paper recently presented to the Russian Physico-Chemical Society, has investigated by a photometric method the absorption of glasses and of quartz, coloured by radium rays, as well as its diminution with time, this diminution being represented by a logarithmic curve. The author describes his experiments made on

quartz, mica, gypsum, and other bodies, showing the alteration of the optical properties of these materials, as occurring under the influence of radium rays. Mica, being placed between crossed nicol prisms, shows an alteration in the chromatic polarisation in the portion which formerly was exposed to the action of radium rays, this alteration disappearing as soon as the specimen is heated. Gypsum and fluorspar, while showing the same alterations of the optical properties, are not blackened under the influence of radium rays.

Business Prospects in the U.S.A.—A statistical inquiry was recently carried out as to the ages and incomes ruling in the electrical business in Chicago. The inquiry was confined to men between the ages of 27 and 45, upon the theory that the older men are the product of a set of conditions which have passed away, while the youngest men are, as a rule, still engaged in a period of preparation. The hundred men may be divided into groups as follows:—

	No. of men.	Average age.	Average income.
Salesmen	7	33	£480
Sales managers	11	36	680
Business men	10	36	960
Sales engineers	8	35	470
Electrical engineers..	16	31	560
Constructing engineers	6	33	570
Electrical experts	8	43	640
Operating engineers	3	32	450
Operating managers and superintendents ..	10	34	710
Professors and editors	8	34	560
Patent attorneys	4	32	800
Consulting engineers	9	40	1,250

Total number of men, 100. General averages: age, 33½ years; income, £688.

Classified in reference to incomes, the record is as follows:—

Income over £2,000 per year..	5 men
Income between £1,000 and £2,000	9 ,,
Income between £480 and £1,000	66 ,,
Income below £480	20 ,,
Total	100 men

An effort was made to make the list representative, and the men were selected on account of their positions without reference to their incomes. It is clear that salaries rule much higher in America than here, and this is but little discounted by the higher cost of living.

Specific Heat of Superheated Steam.—According to a formula by Neyrauch, the specific heat of superheated steam is given by the following formula:—$c_p = 0{\cdot}4304 + 0{\cdot}000378\ t$, where t is the temperature Centigrade. The following are a few of the specific heats worked out from the above:—

Temp. C.	Temp. F.	Sp. Ht.	Temp. C.	Temp. F.	Sp. Ht.
100°	212°	·4718	320°	608°	·5549
160°	320°	·4945	340°	644°	·5625
200°	392°	·5096	360°	680°	·5701
260°	500°	·5322	400°	752°	·5852
300°	572°	·5474			

Institution of Gas Engineers.—The following are among the papers which are down for reading before the annual general meeting of this Institution June 7th, 8th and 9th, at the Institution of Mechanical Engineers:—

De Brouwer Stoking Machinery at Derby, by Mr. J. Ferguson Bell, of Derby.
Roadways and their Relationship to Various Public Services, by Mr. A. E. Broadberry, of Tottenham.
Condensation of Illuminating Gas, by Dr. Harold G. Colman, of London.
Ten Years' Experience with the Prepayment Meter, by Mr. Alfred Colson, of Leicester.
The Flow of Gas in Mains and Distribution at High Pressures, by Prof. W. C. Unwin, F.R.S.

A lecture on "The Mechanism of Combustion," will be delivered by Prof. Harold B. Dixon, M.A., F.R.S., on the morning of June 8th.

London Chamber of Commerce—Electrical Trade Section.—At the last meeting of this section several matters of interest to the electrical industry were dealt with. The section considered and generally approved the provisions of the Supply of Electricity Bill—subject to slight modifications on points of detail—as being a necessary measure which will have the effect of removing the difficulties which have arisen in the past in the development of the electrical supply industry. (The Council of the Chamber subsequently endorsed the views of the section, and resolved to address the president of the Board of Trade expressing the hope that in view of the urgency of legislation on the lines of the Bill, the Government might see its way to grant facilities for its passage during the present session of Parliament.) A discussion also took place with regard to certain draft regulations arising out of the report of the Departmental Committee on Electricity in Mines, which it was suggested would affect the electrical industry generally as well as the mining industry in particular, and might also become the basis of future regulations affecting the whole electrical industry. A resolution was passed (and has since been confirmed by the Council of the Chamber) to the effect that the attention of the Home Office should be called to the matter with a request that any draft proposed regulations which may be under consideration, may be submitted to the Chamber in order that the electrical section may have an opportunity of considering the same, and submitting their remarks to the Home Office before the regulations are put into force. The Valuation Bill as affecting electrical and other large industrial undertakings was also considered. Certain general objections were made to the Bill, more especially (*a*) that it is unsound in principle that a great spending authority such as a county council should itself be the valuation authority; (*b*) that the bodies which will control the assessments are themselves competing with traders; (*c*) that the valuation authorities will appoint expert valuers, and that there is no security under the Bill that the system of payment according to the amount of the assessment secured by their efforts will be discontinued; (*d*) that there is no machinery by which a ratepayer can appeal to a competent independent court. It was agreed to co-operate with other sections of the Chamber in giving effect to the views of the section, and bringing them before members of Parliament. The Council of the Chamber subsequently referred the matter to its General Purposes Committee for early action.

Wimbledon Electrical Exhibition.—An exhibition of electrical apparatus was held at the Worple Hall, Wimbledon, under the auspices of the Electricity Department, from the 18th to 28th ult. The principal local firms and others well known in the electrical industry combined to make an excellent display of the many uses to which electricity can be adapted for business, domestic and medical purposes. Credit is due to Mr. H. Tomlinson Lee, the Council's electrical engineer, and the various firms through whose efforts so successful a result was obtained.

Among the numerous exhibitors who were prominent we noticed the Linolite Co., of Westminster, who had fitted up a small kiosk to demonstrate the various uses of their speciality. Linolite is making exceptional headway as an internal illuminant for reflected lighting, and for shop window lighting work its capabilities were effectively demonstrated in the two windows arranged on the stand.

The Langdon-Davies Motor Co., Ltd., exhibited several of their small induction motors, specimens of which were shown in operation coupled to boot-finishing, bread-making and wood-working machines; they also exhibited switches, starting resistances, and a Baker reducing gear.

Messrs. Whitehead Bros., Wimbledon, made an excellent show at their stand, of Prometheus heating appliances, ventilating fans, art metal fittings, distributing boards, telephone and small switchboard fittings. A Metzler piano player adapted for electrical driving was also on view.

Messrs. Spearing & Stark, Wimbledon, displayed a high frequency apparatus applicable to experimental and surgical work which proved a centre of great attraction. A flexible braiding machine, driven by a Heyland motor, was also shown in operation, and other exhibits included an oscillating fan, small dynamos for accumulator charging, art metal fittings and lamps, small electrical and switchboard apparatus, "Perfecta" tubing, &c. Some genuine Japanese art metal "Dragon" fittings were also on view, adapted for electric lighting.

A display of electric candle-lamps in conjunction with the Cooper illuminating table cloth, and Maxim patent locking devices for incandescent lampholders were exhibited by the Sir Hiram Maxim Electrical and Engineering Co., Ltd., together with tubular lamps in fittings for window and interior lighting.

Messrs. Foster & Co., Wimbledon, of hot-wire arc lamp fame, displayed six lamps of their well-known type. That this firm's productions are being appreciated may be judged from the fact that recent orders include 36 arcs for the street lighting of Wimbledon, 78 arcs by a private firm in Fulham, 58 arcs for the Brush Co., &c., while over 200 of these lamps have been supplied owing to their special adaptability to changing over to either alternating or direct supply.

The Dowsing Radiant Heat Co., Ltd., had a room specially fitted up for treating patients by their "dry heat" methods, where, under the able exposition of Nurse Simmonds, visitors were initiated into the mysteries of their treatment of neuralgic, rheumatic and similar ailments. A Dowsing lupus light apparatus and an electrical exerciser were also on view.

Other exhibitors included the Hotchkiss Boiler Cleaner Co., Messrs. Arthur Howard & Co., P. F. Buddery, the Simplex Steel Conduit Co., the Electric Railway and Tramway Carriage Works Co., Preston (who showed a model single-truck, double-deck car), the Robertson Lamp Co., &c.

The exhibition proved a great source of attraction to the local public, and we gather that its business results have been equally satisfactory to the exhibitors.

More Marvels.—We fear someone has been getting at the *Northfleet Times*, which comes out with a terrific description of one Painton, who is described as about to revolutionise all naval propulsion by means of electricity. Forty-four knots are set down as the speed to be attained by the Painton system of dynamos, motors, and multiple propellers. We now learn that a vital part of Painton's invention was pillaged by the British Government and built into the *Cobra* and *Viper*. The new craft is apparently to bristle with screws, which are to stick out all over, and doubtless in place of venomous reptiles future vessels will be termed Hedgehog and Porcupine. The only point omitted in this Press account of a marvellous bundle of inventions is the trolley wire system, by which electricity is to come aboard, for steam, apparently, has no place in the new ship. Perhaps they will drive the dynamo by a tidal motor, or, better still, drag it astern like a patent log with spiral vanes, so that the faster the ship goes the faster the dynamo will revolve, and the more current will be produced.

Municipal and County Club.—The last house dinner of the season—when the Lord Mayor of London was the guest—was held on Thursday night at the Club, Whitehall Court. Mr. G. L. Gomme, F.S.A., the President of the Club, was in the chair.

Pulverised Coal for Steam Raising.—As to the theory of burning pulverised coal there can be but one opinion. Solid fuel can be best burned when reduced as nearly as possible to the form of gas and mixed with a correct proportion of air and burned in a suitable furnace. But there are certain difficulties in practice which have so far prevented the process from being an unalloyed success. One of these difficulties is that the incombustible parts of the coal are ground up equally with the combustible portions, and give rise to various nuisances local and general. A paper on this subject has been read before the Western Society of Engineers by Mr. J. M. Sweeny, and the general trend of his remarks is not to the effect that the process is anywhere a success, and the only success was said by one speaker to have been secured in England. Without saying that steam has not been raised or cement burned by means of dust fuel, we are bound to say that the dust fuel system, as it appears to an outsider, presents points of great public inconvenience. The road between Swanscombe and Northfleet, alongside of the dust fuel process worked by the Associated Cement Union, is black with coal dust; the atmosphere is full of it, dense smoke envelops the locality, and all is filthy, or was when last seen, complaints were also rife. We cannot credit the claim made that coal can be ground for 5d. per ton. It was stated that coal containing up to 15 per cent. of moisture can be ground without clogging in a cyclone pulveriser, for the current of air driven through with the coal dust will absorb 10 per cent., and the coal itself can carry the other 5 per cent. One of the difficulties with dust fuel is, of course, the filthy mess it makes unless everything, from the lump coal hopper to the furnace, is practically steam-tight, so searching is the fine dust. The heat in the furnace is always great and apt to be local or concentrated, and furnace linings, which must be refractory, do not last long. One feed apparatus employed consists in part of a steel brush, but there appears to be a good deal of trouble from clogging of the dust. One experimenter found that maintenance and other costs more than cancelled the undoubted economy of the principle.

Pulverising machines, according to one speaker, fall off rapidly in efficiency with increase of moisture in the coal. Coal grinding, like cement grinding in America, seems to be carried on with ball and tube mills and such crude appliances which in this country are not looked on as the highest development of grinding machines, their wear and tear being excessive, and their product devoid of that floury nature which the best experts look upon as so valuable.

Much greater importance appears to have been attached to the practice of the Associated Cement Manufacturers of England than we should be disposed to give.

On the whole, the paper was somewhat inconclusive, but appears to confirm at once the economy and the costliness of the system of coal dust combustion.

Lectures.—With a view of establishing next session systematic courses of study in the applications of electricity to chemistry, an introductory course of four lectures on "The Present Position of Electro-Chemical Engineering," is being arranged at the Manchester Municipal School of Technology for Thursday evenings, commencing June 9th. The lectures will be delivered by Prof. W. W. Haldane Gee, B.Sc.

Rubber in Bolivia.—The *St. James's Gazette* says that Sir William Martin Conway's discoveries in Bolivia indicate a vast source of untapped wealth. "He estimates that its forests contain 50 million rubber trees, the product of which would mean wealth so far beyond the dreams of avarice that the imagination boggles at its estimate."

Royal Society.—The following papers were down for reading yesterday afternoon:—

Prof. Svante Arrhenius, "On the Aurora Borealis and the Electric Charge of the Sun." Communicated by the President.

A. Mallock, F.R.S., "On a Direct Method of Measuring the Coefficient of Volume Elasticity of Metals."

Prof. A. E. H. Love, F.R.S., "The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator."

Dr. S. Bidwell, F.R.S., "On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel."

Dr. H. A. Wilson, "On the Electric Effect of Rotating a Dielectric in a Magnetic Field." Communicated by Prof. J. J. Thomson, F.R.S.

Conference Relating to the Electric Lighting Acts.—A conference of representatives appointed by the local authorities and companies owning electricity undertakings is to be held at the Town Hall, Pancras Road, N.W., to-morrow, Saturday, June 4th, at 12 o'clock noon, to consider as to the advisability of petitioning the Board of Trade to promote legislation for the repeal or modification of the undermentioned and similar clauses in the Electric Lighting Act and Electric Lighting Orders, so as to prevent actions being taken against undertakers unless serious damage or nuisance is occasioned through the carrying on of their works, and also for empowering the undertakers, in that event, to compulsorily acquire the interests which are affected thereby, viz.:—

Clause 71, St. Pancras (Middlesex) Electric Lighting Order, 1883—"Nothing in this Order shall exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of any nuisance being caused by them."

Clause 17, Electric Lighting Act, 1882—"In the exercise of the powers in relation to the execution of works given them under this Act, or any license, order, or special Act, the undertakers shall cause as little detriment and inconvenience and do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason or in consequence of the exercise of such powers, the amount and application of such compensation in case of difference to be determined by arbitration."

Australian Patent Law.—A cable received by the Chartered Institute of Patent Agents in London, states that the Australian Commonwealth Patents Act has been proclaimed, and is now in force. This enables protection to be obtained in the six States by a single patent.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the power station or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.*]

Central Station Engineers.—Mr. C. F. BUTLER, A.M.I.E.E., of the County of London Electric Supply Co., Ltd., has been appointed managing engineer to the Hertford power station of the North Metropolitan Electrical Power Distribution Co., Ltd.

The Gloucester T.C. has agreed to increase the salary of Mr. W. J. BACHE, the electrical engineer, to £300 per annum, and to allow him to take two pupils.

At Southport, on May 29th, the wedding took place of Mr. H. TOMLINSON-LEE, chief electrical engineer to the Wimbledon U.D.C., to MARY, eldest daughter of the late Mr. J. B. L. BASTOBLE, L.R.C.P., of Southport. The honeymoon is being spent in North Wales. The wedding presents included a clock and silver cigarette box from the officials and staff of the Wimbledon U.D.C., a silver flower bowl from members of the Council, and a dessert service from the Electricity Works staff.

On Tuesday last week Mr. S. E. BRITTON, who is leaving the Motherwell Electricity Works, was entertained at supper by the staff, and was made the recipient of a silver tea service.

The electrical engineer of Lancaster is to be allowed to take pupils at the Electricity Works, the premiums of £100 for two years to be equally divided between the Council and the engineer.

The E.L. and Tramway Committees of the Rotherham T.C. have recommended that the salary of Mr. E. CROSS, electrical engineer, be increased by £50 per annum.

Mr. A. J. HEDGCOCK having resigned the position of resident engineer at Beckenham Electricity Works, Mr. J. E. SAPPER, late chief assistant, has been appointed resident engineer in his stead.

Electric Tramway Officials.—Derby T.C. has appointed Mr. R. WILSON as clerk of the works of the permanent way of the electric tramways, at a salary of £3 10s. per week.

The Rotherham Tramway Committee has increased the salary of Mr. W. GRANT, the tramways manager, by £50.

The *New Zealand Herald* says that Mr. PAUL M. HANSEN, managing director of the Auckland Electric Tramways Co., is about to pay a visit to England, travelling by the 'Frisco route.

General.—We regret to record the death, in his 78th year, of Herr FRIEDRICH SIEMENS, the last surviving brother of Werner von Siemens.

The death is announced of Col. B. H. MARTINDALE, C.B., A.M.I.C.E., who was a director of the City of London Electric Lighting Co. The deceased gentleman was 80 years old at the time of his death, which occurred on May 26th at his residence at Albury.

Mr. CLEMENT HIRTZEL, the concessionnaire for electric power and lighting in Nairobi, British East Africa, has arrived in London. Mr. Hertzel proposes to visit the St. Louis Exhibition, and inspect the latest machinery on show there.

The death is announced of Mr. LEONARD COOPER, of Harrogate, who occupied, among other positions, that of managing director of the Cooper Patent Anchor Joint Co.

The *Bulawayo Chronicle*, of May 4th, says that "Messrs. H. B. GEMMELL, R. M. HALL, and CHARNOCK, of the railway, together with Mr. F. C. POLDEN, A.M.I.E.E., electrical engineer of the railway, have left on a business trip to the Victoria Falls. They will be able to return in about a week, in consequence of the rails being laid to the Falls."

Mr. C. GODWIN, of Salisbury, has been appointed chief clerk to the Salisbury Electric Light and Supply Co., Ltd.

A New Zealand paper says that on April 14th the Mayor of Dunedin, accompanied by Mr. GOODMAN, electrical engineer, left Dunedin for Auckland to attend the sitting of the Arbitration Court in regard to the Auckland tramway dispute.

The employés of Messrs. A. B. Robertson & SON, electrical engineers, of Aberdeen, last Friday presented Mr. ROBERTSON, jun., with a walnut roll top writing table on the occasion of his forthcoming marriage.

We regret to learn that Messrs. Berry, Skinner & Co.'s traveller in the South-West district, Mr. D. SCARR, was seriously burnt in a fire which occurred at Smart's Hotel, Bristol, early on Friday morning last, the 27th ult.

Councillor MACKENZIE, who has for many years been so assiduous in his attentions to the Edinburgh municipal electricity supply department, and has been largely responsible for the discretion which has always characterised the working of the undertaking, and the success which has attended it, has resigned his seat on the Edinburgh City Council.

The employés of the Hove Electric Lighting Co., Ltd., went for their second annual walk to Steyning and back (21½ miles) last Saturday afternoon. There were eight entries. The first man home

was W. H. Harper, who did the race in 3 hours 53¾ minutes. Harper was also last year's winner. The handicap prizes were carried off by Pells (first), Gunnell (second), and Pay (third).

Mail advices from Washington, D.C., under date of May 21st, record the death of William Wallace, a prominent American electrical engineer. He was born at Manchester on March 16th, 1825, and in early life left England to go to the United States, and established the firm of Wallace & Sons, at Ansonia, Connecticut. The firm soon became one of the leading manufactories of copper and brass alloys in the United States. Becoming associated with Moses G. Farmer, they began the manufacture of a compound telegraph wire, consisting of a steel core and an electrotyped copper covering, thus giving conductivity and strength, combined with lightness. In 1876, at the Centennial Exhibition, Mr. Wallace brought out the Farmer-Wallace dynamo machine, with which the buildings were successfully lighted.

The staff of the Glasgow Corporation Telephone Department met on Tuesday evening to present Mr. A. R. Bennett with an illuminated address on the occasion of his retirement from the office of general manager. The chair was occupied by Ex-Bailie Alexander, convener of the Telephone Department. In making the presentation, Mr. Macfee referred to Mr. Bennett's strenuous efforts in connection with municipal telephony. In reply, Mr. Bennett suitably thanked the staff. Further remarks were made by Messrs. M'Callum, Chambers, Eastman and Angus. The address was designed by Mr. Twining, the chief draughtsman of the Department.

NEW COMPANIES REGISTERED.

Nealeron, Ltd. (81,056).—This company was registered on May 25th, with a capital of £3,005 in 2,005 shares of £1 each, and 4,000 "B" shares of 5s. each, to carry on the business of manufacturers and importers of and dealers in electric accumulators, electric bells, electric carbon, electric fuse, and all appliances for electric blasting, portable electric lights, electric lamps, electric lamp regenerators, electric light casings, conduits, dynamo machines and fittings, electric motors, electric wire and cable machinery, electrical batteries, instruments and accessories, electricity meters and the like, electricians, suppliers of electric current, &c. The first subscribers are:—G. F. Herron, Westwood, Walton-on-Thames, electrical engineer, 2,000 "A" shares; J. E. Neale, 20-8, Dalling Road, Hammersmith, W., electrical engineer, 1 "B" share; N. Reynolds, 5, Arundel Street, W.C., solicitor, 1 "A" share; I. Tofts, 11, Handforth Road, Brixton, S.W., clerk, 1 "A" share; S. J. Passmore, Rocklands, Westwood Park, Forest Hill, S.E., clerk, 1 "A" share; E. Dubois, 18, Eldon Street, E.C., solicitor, 1 "A" share; and E. F. Smith, 57, Bishop's Road, Victoria Park, N.E., clerk, 1 "A" share. No initial public issue. The first directors are G. F. Herron and J. E. Neale; qualification, £100; remuneration as fixed by the company.

Vernon Mechanical and Electrical Registers, Ltd. (81,086).—This company was registered on May 27th, with a capital of £25,000, in £1 shares, to acquire the various inventions of Albert Marsh relating (*inter alia*) to delivering, receiving and registering tickets and checks with the British-American patents and rights obtained or applied for in respect thereof, to adopt an agreement with the said A. Marsh and S. Ford, and to carry on the business of manufacturers of, and dealers in, mechanical and electrical indicating and registering appliances, turnstiles, gates, tickets and checks, &c. The first subscribers (each with one share) are:—S. Ford, 12, Southampton Street, Fitzroy Square, W., merchant; F. J. Ford, 71, Ashmore Road, Paddington, W., clerk; E. Daniel, 50, Osborne Terrace, S.W., civil engineer; A. Dewey, Carisbrooke, Finsbury Park, N., clerk; B. R. Bowman, 16, Gladys Road, West Hampstead, N.W., A.C.I.S.; E. Greenwood, 38, Narford Road, Clapton, N.W., accountant; and J. Baker, 95, Cannon Hill, West Hampstead, N.W., gentleman. No initial public issue. The subscribers are to appoint the first directors; qualification, £100 shares or stock; remuneration, £100 each per annum (£50 extra for the chairman), and 10 per cent. of the net profits remaining after 10 per cent. has been paid on the ordinary shares, divisible. Registered office, Eldon Street House, E.C.

Penmachno Corwen and Bettws-y-Coed Light Railway Co., Ltd. (81,082).—This company was registered on May 27th, with a capital of £3,000 in £1 shares, to construct or acquire light railways and tramways in the counties of Carnarvon, Denbigh and Merioneth, or elsewhere, to equip, maintain, and work the same by horse, steam, electrical, or other animal or mechanical power and to carry on the business of railway and tramway proprietors, carriers of passengers and goods, omnibus and van proprietors, electricians, mechanical engineers, suppliers of electricity for light, heat, motive-power, or otherwise, manufacturers of and dealers in electrical machinery, &c. The first subscribers are:—A. Carter, 2, South John Street, Liverpool, merchant, 20 shares; J. Roberts, P.O., Pentre, Voelas, merchant, 20 shares; J. Davis, Connemara House, Corwen, draper, 1 share; H. Maconochie, Heath Brow Cottage, Hampstead, merchant, 20 shares; J. L. Owen, 24, Kenilworth Road, Ealing, W., civil engineer, 20 shares; H. G. Keith, 25, Victoria Street, W., mining agent, 1 share; and A. Mansfield, 25, Victoria Street, W., civil engineer, 1 share. Minimum cash subscription, 10 per cent. of the shares offered to the public. The number of directors is not to be more than eight; the first are H. Maconochie and J. L. Owen: qualification, £20; remuneration as fixed by the company.

Sprague Elevator Co., Ltd. (81,047).—This company was registered on May 21st, with a capital of £5,000 in £1 shares, to carry on the business of constructors of, and dealers in, lifts, elevators, cranes, hoists, and lifting machinery of all kinds, and apparatus, machinery, and appliances used in connection therewith (whether worked by hand, mechanical, hydraulic, or electrical power), hydraulic, electrical, mechanical, and general engineers, electricians, agents, suppliers of electricity, iron and brass founders, &c. The first subscribers (each with one share) are:—J. E. Powell, 54, Darnley Road, Hackney, N.E., accountant; H. R. Price, 22, Great Bland Street, Newington, clerk; F. Boon, 21, Princes Square, Kennington, clerk; E. Burnel, Upland Hall, Forest Hill, S.E., designer; T. M. Law, 28, Lendiver Road, Wimbledon, clerk; W. Harrington, 4, The Broadway, Denmark Hill, S.E., accountant; and A. J. Penwarden, 221, Henley Road, Ilford, clerk. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Church Stretton Electric Supply Co., Ltd. (80,857).—A trust deed, dated May 19th, to secure £5,000 debentures, created May 18th, 1904, charged on certain land at Church Stretton, the full benefit of the Provisional Order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, to the Church Stretton Land Co., Ltd., in respect of the Urban District of Church Stretton and the parishes of All Stretton and Little Stretton, Salop, and the company's other assets, present and future, including uncalled capital, has been registered. Trustees: Sir R. G. Head, 2, Sussex Place, Hyde Park, and Major A. P. Bethune, The Mount, Seaton, Devon.

India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd. (1,122 C).—Issue, on May 17th, of £1,000 second debentures, part of series created April 12th, 1904, to secure £100,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to £300,000 debentures, issued in 1896. No trustees. Previously issued of same series: £99,000.

Metropolitan Electric Tramways, Ltd. (42,526).—A trust deed, dated April 28th, 1904, to secure £250,000 debenture stock, created by resolution of March 23rd, 1904 (with power to issue further stock ranking *pari passu* up to half the issued capital for the time being), has been registered. Property charged: (1) Tramways and buildings comprising the tramway undertaking of the company in Middlesex; (2) Tramways, buildings and land, comprising the undertaking of the Harrow Road and Paddington Tramways Co., agreed to be purchased by the company; (3) Light railways in Middlesex and Herts, agreed to be leased by the company; (4) Shares in and money due from the North Metropolitan Electric Power Supply Co.; and (5) The company's general assets and undertaking, present and future, including uncalled capital. Trustees: Electric and General Investment Co., Ltd., 1—2, Great Winchester Street, E.C.

Empress Manufacturing Co., Ltd., electricians, London (79,369).—£1,200 debentures, created 9th, and dated May 17th, 1904, charged on the company's property, present and future, including uncalled capital, have been registered. No trustees.

ELECTRICITY SUPPLY ACCOUNTS.

Bristol Municipal Electricity Supply.

The Bristol Electricity Department's returns for the past year exhibit many features of interest. The lighting additions were greater than in any previous year, motive power connections have risen from 1,288 H.P. to 2,306 H.P., and public arc lighting has been extended from 310 to 674 lamps. These satisfactory developments have been accompanied by decreased average working expenditure, and after meeting financial charges, a net profit of £8,220 remains, as compared with £5,872 in the previous year.

The works costs only of the Temple Back works were 1·09d., and of the Avonbank works ·89d., the difference in favour of the latter being due entirely to lower coal costs.

The net profit was principally allocated to the reserve and depreciation funds, which together amount to £11,900.

The prices charged are:—Private lighting, 3½d. (day) and 5d. (night) per unit; power, 1½d. with discounts; public arcs, £23 per annum, including attendance and repairs. The chief engineer is Mr. H. Faraday Proctor.

General Statement.

For year ending March 25th—	1904.	1903.
Total capital expended	£542,244	£453,290
Number of units sold—		
Private supply	3,686,191	2,933,775
Public lighting	613,313	475,983
Total number of units sold ...	4,299,504	3,409,758
Equivalent No. of 8-c.p. lamps connected	234,098	182,134
H.P. of motors connected	2,306	1,288
Number of public lamps	674 arc	310 arc
	8 inc.	9 inc.
Maximum load in KW.	3,444	2,831
Revenue account—		
Gross revenue	£61,372	£52,810
„ expenditure	£29,841	£25,645
„ profit	£31,531	£27,165
Average inclusive price obtained per unit—		
Private supply per meter, &c.... ...	3·39d.	3·70d.
Public lighting	3·48d.	3·60d.

Revenue Account for Year ending March 25th, 1904.

Gross revenue	£61,372 = 3·44d. per unit.
Works and distribution costs (including public lighting)	£21,423 = 1·20d. „
Total working costs	£29,841 = 1·66d. „

Profit Statement.

Interest on loans	£13,967
Sinking fund	9,357
Balance carried forward	8,220
Balance brought forward from last account ...	−13
Gross profit	£31,531

Kingston-upon-Thames Municipal Electricity Supply.

For this riverside borough, the past year will rank as the most satisfactory through which its electricity undertaking has passed. Since its inception in 1896, adverse circumstances have combined to produce a run of ill-luck in the shape of deficiencies, until the present year's net profit of £103 breaks the spell. The contributing features to the above appear to be the increasing popularity of the supply, and the improved efficiency of the generating plant, fuel costs showing a reduction of £300 in total, and of ·4d. per unit, as compared with the previous year.

The prices charged are :—Private lighting, 7d. and 3d. per unit, demand indicator system ; power, 3d. per unit. The chief engineer is Mr. J. E. Edgcome.

GENERAL STATEMENT.

For year ending March 31st—	1904.	1903.
Total capital expended	£86,468	£82,784
Number of units sold—		
Private supply	347,285	312,706
Public lighting	113,343	80,256
Total number of units sold ...	460,628	392,962
Equivalent No. of 8-c.p. lamps connected	28,603	25,767
Number of public lamps	76 arc	76 arc
Maximum load in kw.	—	362
Revenue account—		
Gross revenue	£10,003	£8,341
„ expenditure	£5,047	£4,930
„ profit	£4,956	£3,411
Average inclusive price obtained per unit—		
Private lighting	5·76d.	5·60d.
Public lighting	3·21d.	2·64d.

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31ST, 1904.

Gross revenue	£10,003 = 5·22d.	per unit.
Works and distribution costs (including public lighting)	£3,789 = 1·97d.	„
Total working costs	£5,047 = 2·69d.	„

PROFIT STATEMENT.

Interest on loans, &c.	£2,141
Sinking fund...	2,712
Year's balance carried forward	103
Gross profit ...	£4,956

CITY NOTES.

Belliss and Morcom, Ltd.

THE report which has just been issued by the directors for the year ended at March 31st, 1904, shows that the progress of this enterprising firm of steam-engine builders was uninterrupted during that period ; indeed, the rate of progress was even greater than in the preceding years. The profit for the year stands at £47,871 7s. 11d., against £39,335 in the previous year, an increase of £8,536, which by no effort of the imagination can be regarded as unsatisfactory, especially when we bear in mind that last year was an unhappy one for certain manufacturing companies whose business is not dissimilar in character. The Belliss engine has undoubtedly had a good run, and especially is that the case in electricity works development, and is it altogether wrong to suggest that a measure of this success has been responsible for the fact that 1903 *was* a bad year for some other makers ? From the Belliss and Morcom balance-sheet we see that £44,050—an amount closely approximating to the profit on the year's trading—was brought forward from the previous year, and thus it happens that there is an unusually large sum available for distribution among the shareholders, or for other purposes. What the directors have elected to do, after payment of the 4 per cent. mortgage debenture interest on £100,000, and the 6 per cent. preference interest on £128,230 (in £10) preference capital, is this :—To give the holders of the ordinary shares £100,070 (£10 shares) a dividend at the rate of 12½ per cent. for the year ; as this only requires some £12,500, there still remains a large surplus, even after £10,000 is placed to the general reserve fund, so it has now been considered that the present state of the undertaking warrants the issuance of four *bonus shares* to every ordinary shareholder, for every 10 such shares already held by him. We have no knowledge as to whether any of the ordinary capital is held by outsiders, but whoever holds them has every reason to congratulate himself. The chief interest in the present report lies in the unmistakeable proof which it gives of the progressive nature of the business, which has paid dividends of 12½ per cent. for three years in succession, and 10 per cent. previously, doubtless due to the fact that the company devotes itself entirely to the business with which it is best capable of dealing, and does not go outside to touch things of which it has little experience.

The company has a reserve fund of £42,012, and a reserve for redemption of leaseholds and depreciation of plant standing at £44,091. Sundry creditors are £45,363 against sundry debtors of £71,693. The buildings, plant and machinery, stand at £209,531 and goodwill at £62,019 ; stock-in-trade and work in progress, £67,893 ; investments appear at £62,845, and there is £69,086 cash at bankers and in hand.

Barcelona Tramways Co.

MR. J. B. CONCANON, presiding at the meeting of this company held at Winchester House on Tuesday, said that the directors regarded the report (see ELECTRICAL REVIEW, May 27th) as extremely unsatisfactory. The receipts had decreased by 3 per cent., and the mileage run was reduced by 7 per cent., and the passengers carried fell by about 21 per cent. The only serious reduction that was made in the working expenses was £1,728 reduction in the cost of current. Maintenance and traffic expenses had increased, also rates and taxes. Debenture interest and sinking fund were £6,240 higher. They were also working, to some extent, on borrowed capital, which meant larger interest on bank loans. Messrs. Brown and Kennedy, directors, went to Barcelona to investigate matters, and as a result changes were made in the local administration. They had had strikes during the past few years, and had made compromises, but they had now appointed a Madrid gentleman—an officer in the Spanish army—as traffic manager, and he was a man of grit and pluck who had had instructions that there was to be no more shillyshallying or making of undeserved concessions. Their losses due to the dishonesty of the staff, were considerable, but as a result of the new arrangements the returns for January, February, and March showed decided improvements. In April the increase was £2,463, and in May £2,166. These increases were entirely due to the fact that the men who had robbed them had been dismissed. If these advances continued, there should be a large net increase at the end of this year. Mr. Brown did not think there was going to be a strike, but if there were, for three or even four weeks, it would be worth the risk in order to get control of the men. The men had approached them for advances in wages in return for the lessened robberies, but they had declined to consider that matter until July. The chairman moved the adoption of the report, and the declaration of 5 per cent. on the preference, and 3 per cent. on the ordinary shares.

Rand Central Electric Works, Ltd.

SIR C. RIVERS WILSON presided at the meeting held at Winchester House on Tuesday, and, in moving the adoption of the report (see ELECTRICAL REVIEW, May 20th), he congratulated shareholders upon the company's improved position and its excellent prospects. They began the year 1903 with an adverse balance of £22,993. The Government had failed to recognise the company's reasonable claim for damages incurred during the war ; indeed, they felt that they had been treated with harshness. Their income for the year was £71,820, which was £18,856 more than in 1902, and £18,043 of that increase was in respect of revenue for electricity supplied and the rent of plant. They had been able to reduce the adverse balance by £11,045 after very liberal allowances for depreciation, so that on January 1st, 1904, there was an adverse balance of only £11,948. The company was now in full work, and the directors were taking steps to put down considerable additional plant. The estimated profit for the first quarter of this year was about £11,000, which was nearly the amount of the adverse balance, therefore he hoped that at the next meeting they would be able to recommence dividend payments on a substantial basis. Owing to the large demand for power, they were obliged to bring their reserve set into full operation, and they had, therefore, after very careful consideration, decided to put down a 400-kw. turbo set, costing £12,000, which was less than they contemplated spending when they thought of putting down a steam engine set. The plant was being obtained under the advice of Messrs. Siemens & Halske, and would be made in Switzerland. They would be able to add another dynamo of the same description for about £3,000 or £4,000 more, and the cost of these extensions would be met out of their cash balances, which, on January 1st, amounted to about £40,000. He thought that they might look forward with great confidence to the future prosperity of the company.

Mr. G. ZWILGMEYER seconded the adoption of the report, and it was carried.

Diesel Engine Co.

THE report for the year ended March 31st last, presented at the meeting held on Monday last, shows a net profit of £6,229, which clears off the loss previously incurred, of £6,152. The initial difficulties which attend the introduction of a new motive power are stated to have been successfully overcome. The business has more than doubled, sales having increased both as regards number of engines and horse-power. The sale of the Diesel engine has been further extended in many of the colonies and foreign countries in which the company owns the patent rights, and there are prospects of a still further increase during the current year. The important question of manufacture has also been satisfactorily settled. The directors have secured their supply of engines from

two large firms of the highest standing, who have undertaken the manufacture of Diesel engines, and are now promptly meeting the demands of the company. The litigation in which the company was involved with an American firm, referred to at the last ordinary general meeting as then pending, has been concluded in favour of this company, judgement having been obtained against the American company for £2,210 damages and costs. The directors are taking the necessary steps to recover this amount, which constitutes the suspense account mentioned in the balance-sheet.

Lisbon Electric Tramways Co.—The report for 1903 states that the result of the company's operations for the past year shows a net profit of £91,803, and after payment of interest on debentures and other charges, besides London office expenses and directors' remuneration, there remains a balance of £59,814, which, added to the balance brought forward, gives an available balance of £65,895. Out of this amount the arrears of preference dividend accumulated during construction to December 31st, 1902, amounting to £12,000, have been paid, and also the dividend of 6 per cent. for the year 1903, amounting to £25,533. The directors have also transferred the sum of £20,000 to depreciation reserve account, leaving £8,362 to be carried forward.

The West Ham Loan.—A financial contemporary learns that the West Ham loan of £500,000, to which we referred last week, and which was offered at 84 for a three per cent. stock, has been anything but a success, the underwriters being left with 33 per cent. of the issue on their hands. Our contemporary is unable to feel any regret at this failure; on the contrary "we consider that such a direct snub administered by the Money Market to a municipality which is notorious for having raised its rates to an excessive pitch will serve as a useful warning to other Corporations which are inclined to extravagance in expenditure."

Nernst Electric Light, Ltd.—The scheme for reconstruction, as detailed on page 886 of our last issue, was approved by the meetings of shareholders held on Tuesday at Westminster Palace Hotel, and the special resolutions were passed (with one dissentient). Mr. Bernard Drake occupied the chair. The confirmatory meeting will be held on June 20th.

Ross Electric Light Co.—A meeting of the company held last week, adopted the first report, which stated that after the payment of all charges there remained a balance in favour of the company of £43 12s., to be carried forward. The demand for current for the quarter ended March 31st last showed a large increase, and the directors believe that the working of the present year would show very satisfactory results.

Stock Exchange Notices.—Application has been made to the Committee to allow the following securities to be quoted in the Official List:—Edmundson's Electricity Corporation, Ltd.—Further issue of £31,467 4½ per cent. first mortgage debenture stock (redeemable). Applications have been made to the Committee to allow the following securities to be quoted in the Official List:—Electric Lighting and Traction Co. of Australia, Ltd.—Further issue of £75,000 5 per cent. debenture stock. Electrolytic Alkali Co., Ltd.—Further issue of 50,000 ordinary shares of £1 each, fully paid, Nos. 152,219 to 202,218; and a further issue of 50,000 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 50,001 to 100,000.

Mexico Electric Tramways Co.—The report for 1903 states that after charging expenses and obligations, &c, a net balance is shown to the credit of profit and loss account of £35,545, which, added to the balance brought forward, gives the sum of £35,728. Out of this sum the usual dividend of 6 per cent. has been paid on the preference shares, amounting to £30,000, leaving a balance of £5,728 to be carried forward.

Edison & Swan United Electric Light Co.—The resolutions which were passed at the meeting on May 12th for reducing the capital of the company were approved at an extraordinary general meeting, held at Winchester House, E.C., on Monday last.

New Issue.—Messrs. Dorman, Long & Co. have been before the public with an issue of £250,000 6 per cent. second mortgage debentures.

STOCKS AND SHARES.

Wednesday Evening.

With the rise in Consols, following the appearance of the Government broker in the market, and hopes of yet cheaper money, there has come a further hardening of values in the prices of the best class of stocks. Once more it is the case that offers of such securities are most difficult to obtain, and the investor who fancies Electricity Supply Debentures, for example, will find his range of choice unexpectedly limited when he comes to attempt a purchase. A similar state of affairs prevails in the telegraph department, and the difficulty of obtaining the stocks has led to a marking-up of about half a dozen Telegraph Debentures this week. The jobbers who deal in both the above-mentioned classes are very chary of selling what they have not got, for the simple reason that they are so likely to be caught out by reason of the scarcity of stocks, and prices have been put up with the idea of tempting some of those investments to market, for which there now exists a healthy demand.

Should the Bank Rate be reduced in accordance with the anticipations of many people, we fear there would be no stopping that shoal of municipal loans floating into London, to which we referred last week. While sound authorities in Lombard Street and the Stock Exchange unite in hoping these issues may be restrained, at all events, until the public capacity for absorbing them has time to grow, it is doubtful whether a number of the needy borrowers could be restrained from offering their wares if the Bank minimum should fall. The fact that West Ham's 3 per cent. at 84 received no gushing welcome from the public, despite the low price of issue—the underwriters being left with over 30 per cent.—may not be sufficient to deter fresh appeals, especially as the temporary shifts that certain corporations have been adopting in order to raise capital, must be growing as irritating as they are irksome. The needs of these bodies, particularly in connection with electrical schemes of various descriptions, are pressing, but if the usual underwriters set their faces against guaranteeing too many municipal loans, the tide may yet be stemmed for a time.

Two slight declines in Edmundson's Ordinary and Preference have left the prices at 5⅞ for each kind, but it remains impossible to get the offer of Debenture stock under 107. Central Electric 4 per cent. Guaranteed Debenture has lost the amount of the interest deducted last week, and is now 106½. Charing Cross Preference shares are 5s. harder at 8⅛, and would-be buyers of Debenture stocks, failing to get these securities, are turning to the Preference list. Metropolitan Preference continue to change hands at 5½, and County Preference have been sold at 11½. Oxford Ordinary are ¼ up at 5⅞, and a large line of shares changed hands the other day at 5½. By an amusing misprint the Stock Exchange Official List added to its other iniquities by quoting Westminster Ordinary at 12½ to 1 on Tuesday night, with one or two other slips of the same kind. But then it is hopeless to expect the Official List to be otherwise than misleading at the best of times, so that a few eccentricities more or less are nothing.

Amongst the railway stocks, Waterloo and City Ordinary has lost a point at 90½, although the approach of the dividend-time is being talked about in the home Railway market. Central London Ordinary has risen 1 to 93½, but the Deferred is 2 down at 84½, while City and South London keeps its price at 51. Districts are not better than 40, the clique that was working at the stock last month evidently being satisfied with the rise for the present; possibly, too, it has other matters to look after, hailing from the other side of the Atlantic. Metropolitans have firmed up to 96⅞. Amongst traction shares, British Electric Ordinary at 10, and the Preference at 10⅜, are both 5s. harder. The improvements look somewhat suggestive in view of rumours that are afloat with reference to the possibility of still more money being required to cope with the company's requirements for extension. A good deal is being done in Anglo-Argentine trams; the Ordinary are 5½, Preference 5⅛, and Debenture 132½. City of Buenos Ayres are also a firmer market at 9⅛, and a good many shares are changing hands round about that price. Calcuttas have been more active, the middle figure being 7¼. Dealings in London United Preference new shares are mentioned at ¼ premium above the issue price of £10 10s., the senior shares being 11⅛, and the Debenture stock unchanged at 103. Potteries have relapsed into their normal state of quietude.

Rises of a point each in several of the Telegraph Debentures are almost the only feature in this market. Anglo-American stocks show a weaker tendency on the extreme inactivity prevailing in the New York Stock Exchange, nor are the trade reports of the country cheery enough to encourage optimism as to the immediate future of the United States, which already feels the check that a coming Presidential Election imparts to business. Globe Preference recovered their dividend of 3s., while the Ordinary at 9, and West Indian Preference at 6, have fallen the ¼ represented by the distributions in both cases. National Telephone Deferred gave way 2 points, to 86½; the other issues being unaltered. India-rubber, Gutta-percha and Telegraph shares are 10s. better, at 19½, upon a small inquiry based on the recent improvement in Telegraph descriptions. Callender's, at 10½, are nominally 2s. 6d. easier, but actually unaltered, the dividend and bonus being equal to 7s. 6d. per share.

Edison & Swan Ordinary are receiving more speculative attention now that the company looks like doing better under its new capital conditions, and the price has advanced to 5s. 6d. buyers. Sir Charles Rivers Wilson speaks of a possible dividend on Rand Central Electric shares 12 months hence, and the price is now 17s. 6d. Fresh falls have taken Westinghouse Preference to 3½ middle, and the Debenture is also weaker at 88½. Sellers of the former might have trouble in getting even 3¼. There is no other quotable change amongst the Industrial shares connected with the electrical industry.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations May 25th.	Closing Quotations June 1st.	Business done week ended June 1st, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	99 —103	99 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛ — 3⅛	2⅛ — 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	6½.	6d/8	6½.	49 — 52	48 — 51	49	48
8,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	94 — 96	92 — 94	95	93⅛
8,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	7⅛ — 7⅞	7 — 7⅛	7⅛	7⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	175 —185	175 —185	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	94 — 96	94½	..
16,000	Cuba Telegraph	10	4 %	6½%	5 %	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	15 — 16	15 — 16	..	..
12,931	Direct Spanish Telegraph	..	..	..	..	.. — ..	.. — ..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	99 —102	100 —103%	..	..
60,710£	Direct United States Cable	20	8½%	8½%	..	10½ — 10⅝	10½ — 10⅝	..	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	..	..	..	99 —102	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	126 —131	126 —131	130½	128½
1,955,555	Do. 3½ % Pref. Stock	100	..	..	..	86 — 89	87 — 90	89	87½
1,534,646	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	105 —108	106⅝	106
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11⅞ — 12⅛	11⅞ — 12⅛	12⅛	11⅛
820,000£	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	105 —108	105	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	6½%	£3 16 7*	5½%	9 — 9⅛	8⅞ — 9⅛ xd	9⅜	8⅞
180,042	Do. do. 6 % Pref.	10	..	..	..	13 — 13½	13 — 13½	13⅛	13
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	15 %	25 — 26	25 — 26	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	..	..	..	99 —102	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10%	10 %	42 — 45	42 — 45	44⅞	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	104 —106	104 —106	105	104
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	87 — 90	85 — 88	87½	86
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	11⅛	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5 — 5½	..	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 — 100	98 — 100	98⅜	..
689,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	104½	104
1,000,000	Do. do. Prov. Certs., 70 % to be paid	..	..	..	..	30 — 32	30 — 32	31⅜	30⅛
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6½%	⅝ — 1	⅝ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	1⅛	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6¾ — 7⅛	6¾ — 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	117 —122	117 —122	118	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾ — 6	5¾ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅞ — 5⅛	4⅞ — 5⅛	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	103 —106	103 —106	104½	..
15,609	West African Telegraph, Shares	10	..	2 %	4 %	5⅛ — 6⅛	5½ — 6⅛	..	..
160,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	97 — 100	97 —100	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	12⅜ — 13⅛	12⅜ — 13⅛	13⅜	12⅛
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	100 —103	100 —103	..	..
88,891	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
34,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	5½ — 6½ xd	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	5 — 6	5 — 6	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 —103	100 —103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	5 — 6	5 — 6	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	90 — 95	90 — 95	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9½ — 10	9⅜ — 10⅛	10	..
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10½ — 10⅝	10⅛ — 11	10⅝	10⅜
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	115 —118	115 —118	117½	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	5½ — 5⅝	5½ — 5⅝	5⅝	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½ — 5⅝	5½ — 5⅝	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —105	102 —105	103½	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅝ — ¾	⅝ — ¾	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	½ — 1	½ — 1	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	6 %	1 — 1⅛	1 — 1⅛	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	96 — 99	96 — 99	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	73 — 78	73 — 78	..	..
85,000	Callender's Cable Construction shares	5	20 %	15 %	12½%	10½ — 11½	10 — 11	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5⅝	5¼ — 5⅝	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 94	92 — 96	..	..
494,998	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —104	101 —104	103	102
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	85 — 88	83 — 86	..	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2¾%	50 — 52	50 — 52	51	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1⅞ — 2⅛	1⅞ — 2⅛	1⅞	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	96 — 99	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	⅛ — ¼	⅛ — ¼	..	..
17,129	Do. do. "A" shares, 01—017,129	5	Nil	Nil	..	⅛ — ¼	⅛ — ¼	..	..
44,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % In Deb. Stock Prov. Certs. all pd.	100	..	..	..	74 — 79	74 — 79	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅜ — 1⅝	1⅜ — 1⅝	1½	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	..	..	..	2¼ — 2⅜	2¼ — 2⅜	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9¼ — 9⅜	9¼ — 9⅜	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	93 — 98	93 — 98	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	11½ — 12¼	11½ — 12¼	11½	..
200,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18½ — 19½	19 — 20	19⅝	19½
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102	99 —102	..	..
97,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅛ — 4½	3¾ — 4	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10½	10 — 10½	..	..
87,850	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	35 — 38	35 — 38	38	36⅝
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,600 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
640,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	90 — 93	89 — 92	90	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (April 21st, 1904).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years			Closing Quotations May 25th.	Closing Quotations June 1st.	Business done week ended June 1st, 1904.	
		‡	1901.	1902.	1903.			Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅝— ⅞	⅝— ⅞	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1 — 1¼	1 — 1¼	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	120 —125	120 —125	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10⅜— 11¼	10⅜— 11¼	10 15/16	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10¼— 10⅜	10¼— 10⅜	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	107 —110	105 —108 xd	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7¼— 7⅜	7⅛— 7⅜	7⅜	7 1/16
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5 — 5⅛	5⅛— 5⅜	5⅛	5 1/16
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅜— 5	4⅜— 5	..	..
40,000	Do. do. 1903	5	..	..	..	4⅜— 5	4⅜— 5	4 15/16	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105	105	..
44,486	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	5½%	6½— 6⅝	6½— 6⅝	6 5/8	6 5/16
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	107 —110	107 —110	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	5 %	5 %	5 %	10⅜— 11¼	10⅜— 11¼	11⅛	10 15/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7½— 8½	7½— 8½	8½	8
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11 — 12	11 — 12	11⅛	..
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	106 —109	106 —109	107½	107
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5⅜— 6½	5⅛— 6	5⅞	5⅝
80,000	Do. do. 6 % Cum. Pref.	..	..	..	..	⅝— 6	5⅝— 5⅞	5⅞	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	105 —108	105 —108	104	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	12%	11½— 12½	11½— 12½	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	102 —105	102 —105	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1¼— 1⅜	1¼— 1⅜	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4½— 5	4½— 5	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	8⅓%	19½— 20½	19½— 20½	19⅞	19 7/8
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	⅝— 5⅝	5⅝— 5⅝	5 1/16	5 1/16
200,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	97½	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	6 %	12½— 13½	12½— 13½	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14 15/16	..
*20,300	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1¾%	3 %	3⅜— 4¼	3⅜— 4¼	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜— 4⅝	4⅜— 4⅝	4⅝	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜— 4⅝	4⅜— 4⅝	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	13½%	12¼— 13⅛	12¼— 13⅛	13⅛	12 13/16
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6¼— 6⅜	6¼— 6⅜	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, June 1st.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£21 10	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	215/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a Crystals	per ton	£8	..
a Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £130	..
c Brass (rolled metal 2' to 12') basis	per lb.	6¼d.	..
c ,, Tube (brazed)	per lb.	8¼d.	..
c ,, ,, (solid drawn).. ..	per lb.	7¼d.	..
c ,, Wire, basis..	per lb.	6¾d.	..
c Copper Tubes (brazed)	per lb.	9½d.	..
c ,, ,, (solid drawn) ..	per lb.	9¾d.	..
g Copper Bars (best selected ..	per ton	£72	..

METALS, &c. (*continued*).

		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£72	..
g ,, Rod	per ton	£72	..
c ,, (Electrolytic) Bars ..	per ton	£64	..
c ,, ,, Sheets ..	per ton	£80	..
c ,, ,, Rod ..	per ton	£74	..
c ,, ,, H.C. Wire	per lb.	8d.	..
f Ebonite Rod	per lb.	3/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	4/10 to 4/10½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	43/6	1/- dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 15	5/- to 7/6 dc.
g ,, ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 2 6	..
d Mica (in original cases) small ..	per lb.	6d. to 1/	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large ..	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
c Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£124 to £125	£2 dec.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
f Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	6¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 1/2d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j ,, 150 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£25 5	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co., *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

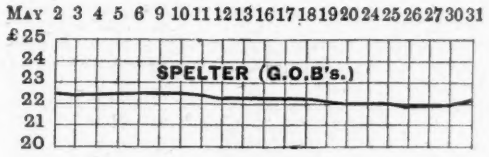
Locality.	Week ending	Receipts for the week.		No. wks.	Total to date.		Miles open.	
		£	£*		£	£*		*
Aberdeen	May 21	1,818	+ 236	51	61,418	+12,549	10	—
Birmingham ..	,, 28	6,483	+1157	22	116,069	+ 7,310	8¼	—
Bournemouth ..	,, 25	1,484	+ 471	95	84,119	—	10½	—
Blackburn	,, 27	1,155	+ 162	9	8,393	+ 699	13½	—
Blackpool	,, 26	1,667	— 136	8	6,275	+ 1,468	8½	—
,, —Fleetw'd	,, 28	1,547	+1173	22	6,855	+ 921	7½	—
,, —Lytham	,, 12	1271	—	28	5,196	+ 4,617	7½	—
Bolton	,, 22	1,752	—287	8	13,618	— 228	25	—
Bradford	,, 21	4,357	+894	7	31,781	+ 5,265	46	—
Brighton	,, 29	1,192	+ 201	—	7,758	—	7½	—
Bristol	,, 27	6,202	+ 109	—	—	—	28	—
Devonport	,, 10	580	+164	20	9,561	+ 1,410	5	—
Dudley—Sto'rb'ge	,, 20	836	+ 57	20	15,491	+ 701	18½	—
Gateshead ..	,, 20	901	+ 59	20	17,398	+ 945	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 20	547	— 2	20	9,821	+ 672	7½	—
Hartlepool ..	,, 20	294	+ 36	10	5,121	+ 547	6½	+2
Oldham—Ashton	,, 20	550	— 3	20	10,291	— 532	8	—
Potteries	,, 20	1,671	+ 39	20	33,317	+ 2,646	28½	—
Southport	,, 20	315	+ 27	20	5,578	+ 3·9	5½	—
South Staffs. ..	,, 20	789	—131	20	15,251	— 143	21½	—½
Swansea	,, 20	592	+ 129	20	9,627	+ 473	5½	—
Wolverhampton..	,, 20	889	+ 16	20	7,011	— 244	10½	+8
Yorks. Wool Dist.	,, 20	630	+279	20	11,007	+ 4,865	6	—
Miscellaneous ..	,, 20	2,891	—	20	46,696	—	—	—
Burnley	,, 28	1,190	+353	—	—	—	10½	+3½
Burton-on-Trent ..	,, 19	426	—	8	3,945	—	5¼	—
Cardiff	,, 21	1,907	+117	—	14,338	+ 717	1	—
Chatham & District	,, 26	714	+162	21	11,472	+ 1,969	8·58	—
Cork	,, 26	599	— 94	21	8,709	— 420	9	—

Locality.	Week ending	Receipts for the week.		No. wks.	Total to date.		Miles open.	
		£	£*		£	£*		*
Dover	May 28	264	+ 40	22	3,927	— 162	3	—
Dublin	,, 27	5,625	+307	22	96,278	+ 2,328	47	+ ½
East Ham	,, 28	942	+301	8	6,441	+ 913	5	+ ½
Glasgow	,, 28	14,993	+243	52	711,607	+60,252	70	+5
Halifax (2 weeks) ..	,, 28	2,624	+403	7	9,598	+ 842	33	+2½
Huddersfield ..	,, 28	1,719	+457	8	—	—	28	—
Hull	,, 28	2,450	+623	8	17,610	+ 1,777	13	+2½
Ilkeston	,, 25	208	— 45	52	8,320	—	4	—
Ipswich	,, 28	751	—	8	3,943	—	10½	—
Isle of Thanet ..	,, 28	953	+370	21	7,331	+ 55	10½	—
Leeds	,, 28	6,979	+1303	—	51,944	+ 4,817	81½	+2
Liverpool	,, 21	10,354	— 62	21	201,208	+ 4,472	103	—
London C. C. ..	,, 28	13,260	+2181	8	93,463	+16,061	37⅜	—2½
Manchester	,, 18	14,712	+2142	8	96,772	+ 3,859	131½	—
Newcastle	,, 28	4,026	+700	—	—	—	17	—
Portsmouth	,, 28	2,487	+610	—	15,813	+ 1,982	14½	—
Salford	,, 23	4,085	+471	—	30,044	+ 4,054	30	—
Sheffield	,, 22	4,629	+ 52	8	27,573	+ 1,067	33	+5½
Southampton ..	,, 26	1,141	+ 72	—	—	—	9	—
Southend-on-Sea ..	,, 25	440	+138	8	2,414	+ 296	6½	—
Sunderland	,, 29	1,655	+465	8	10,436	+ 721	20	+1
Tyneside	,, 25	598	+139	21	6,504	+ 1,037	8·9	+·4
West Ham	,, 26	1,347	—	13	7,742	—	8	—
Wolverhampton ..	,, 25	473	+40	—	—	—	7·563	—
Cen. London Rly..	,, 28	6,493	—1·5	22	151,080	— 2,033	6	—
City & S. Lon. Rly.	,, 29	2,675	— 58	22	66,111	— 2,106	6½	—
Dublin—Lucan Rly.	,, 29	159	+ 77	22	2,299	+ 211	6½	—
L'pool Overh'd Rly.	,, 29	1,908	+245	22	34,714	+ 883	6½	—
Mersey Railway ..	,, 28	1,884	+ 298	21	31,201	+ 6,988	4½	—

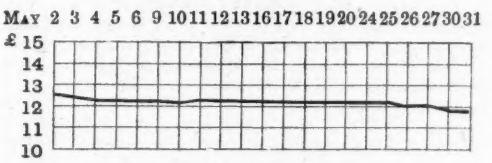
* Compared with the corresponding period of 1903.

METAL MARKET.

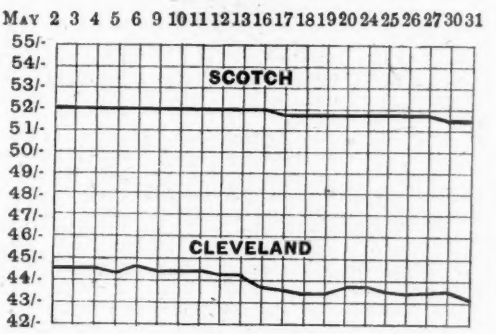
Fluctuations in May.



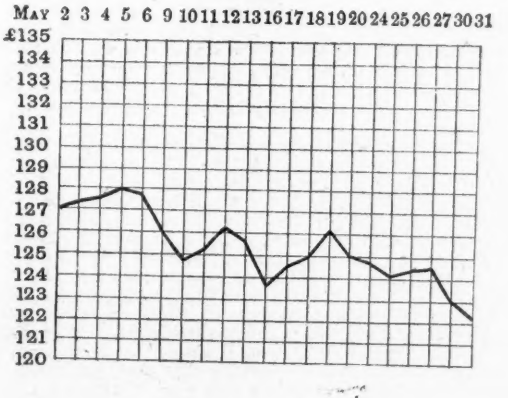
LEAD (ENGLISH).



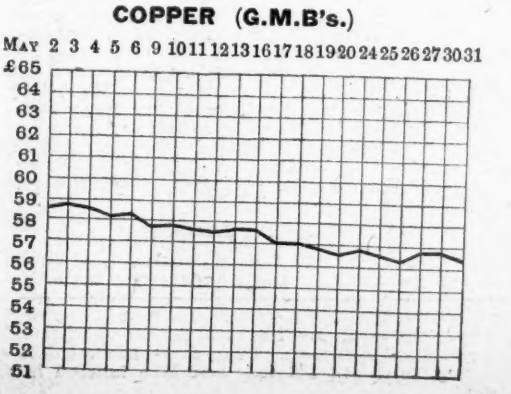
IRON.



TIN.



COPPER (G.M.B's.)



SUPERHEATING.

A PAPER on "Superheating" was read by Mr. C. L. Simpson, A.M.I.C.E., at a meeting of the Civil and Mechanical Engineers' Society, held at the Caxton Hall, Westminster, on May 5th.

An intense obscurity, punctured by a few feeble rays barely sufficient to enable the lecturer to follow his notes; a ghostly screen, on which an assistant cast the subject of the illustrating slides; and a gentle dropping voice, distilling faint dispraise over the general, with a view of bringing into gentle relief the special qualities of the particular, were the somewhat dispiriting conditions under which the audience were invited to consider a subject of such considerable importance to engineers at large. There was also the drawback that some of the slides gave a blurred effect, the most important one of all, a comparative table of tests, being quite indistinct.

A few bold diagrams, conveying a general idea of the apparatus under consideration, would have been better, in a cheerfully lighted hall, and would have produced a better discussion, which is, after all, the really educating factor of most papers.

The lecturer reviewed the various superheaters at present in use, and outlined their principal features, touching on their merits and drawbacks. Speaking of the Schmidt system, he pointed out that, in spite of the splendid showing in steam consumption, claimed to be as low as 6½ lbs. per H.P.-hour under some conditions, the drawbacks of excessively high superheat more than counterbalanced the coal saving, although this was not so great as might be inferred from the considerably lessened steam consumption in specially designed engines. The unreliability of the valves of these engines, owing to the high temperature, leads to many delays and breakdowns.

In contrast to this system the Babcock & Wilcox superheater was instanced as giving good results with moderate superheat, but its position in the combustion chamber, the only available one, precluded anything beyond 100° to 120° F. The dangerous flooding necessary with this method, and the consequent scaling of the pipes, was referred to as likely to bring about disaster to the steam cylinder.

The Simpson and the Simpson-Mcphail superheaters, with which the lecturer identified himself, were then considered in detail; the latter, in his opinion, was the better of the two forms, as the temperature of the superheat was less variable. He spoke favourably of cast-iron as a suitable material for headers, but acknowledged that the Boiler Insurance Companies would have none of it. It was to be deduced that the Simpson group gave best results at the moderate boiler pressure of 125 lbs., as at this pressure and superheating to 150° safe economies at the engine end were assured. It is to be assumed that there are no shortcomings in this form of superheater, for none were referred to, but it would have added to the zest of the evening had a partisan of other types been allowed five minutes in which to expound other views.

The use of superheated steam on foreign railways was then dealt with, and the application of the superheater illustrated on the screen. Considerable economy having been shown in the various tests made, a large number of locomotives at the present time are being fitted with superheaters, especially on the German railways.

In speaking generally of superheat the lecturer considered 500° F. as the safe limit. He is to be congratulated on his insistence that the most important function of superheat is to prevent initial condensation in the cylinder.

Superheating seems to be regarded by many engineers as a sort of scientific porcupine, to be handled very gingerly under compulsion, and to be gladly dropped at the earliest opportunity. In view of the fact that all further improvements in the reciprocating engine and the turbine seem to be along superheating lines, this is simply an impossible position for English engineers to take up, as it will certainly retard all further development in this country; and unless the subject is tackled with intelligence and earnestness, they will find themselves lagging considerably behind the German and the American in the race for the engineering blue ribbon.

As an excuse for this unfortunate attitude, it has been urged that the ordinary form of superheater in use displays so many feminine characteristics, particularly an uncontrollability of temper, varying from the sullen to high-kicking hysterics, that the already too worried engineer, to save himself from final exasperation, is obliged to look askance at its alluring overtures.

Superheaters, to be safe, should be controllable by means that do not waste fuel. They ought not to require water flooding in order to preserve them from burning out, and they ought not to have steam-way areas so narrow as to throttle down the pressure, as they often do, from 12 to 20 lbs. These virtues are all easy enough to secure if one is willing to pay for them, but they cost money.

We are sorry the lecturer did not furnish information on materials for high temperature, and on the effect of superheated steam on the cast-iron boxes which are so mistakenly employed for headers.

Nor did he state the throttling effect of wire-drawing when practised for preservation purposes, or furnish information on the specific heat of superheated steam, on its effects upon mineral oils or on the proper point of lubricating cylinders using superheated steam.

INSTITUTION OF ELECTRICAL ENGINEERS.

POWER STATION DESIGN.

By C. H. Merz, Member, and Wm. McLellan, Associate Member.

(*Paper read in London, April 28th*, 1904.)

(*Continued from page* 891.)

4.—Auxiliary Machinery.

A careful analysis of the repair and labour accounts of any power station, especially one where steam turbines are installed, shows that a very large percentage of the items are accounted for by the auxiliary machinery and apparatus. When we also consider that they represent about 10 per cent. of the total power installed in the station, it is evident that in order to fulfil the essential conditions we have laid down, it is worth while devoting considerable attention to the choice and arrangement of this apparatus. When a main unit is running the whole of the corresponding auxiliary plant is operating at practically full load, whatever be the load on the main unit. As a consequence the auxiliaries are responsible for about 15 per cent. of the total coal bill of the station—due regard therefore should be paid to their economy. On the other hand, the factors governing the design of auxiliaries are the same as those controlling the choice of the main plant; that is to say, they must provide as effectively as possible, first for the reliability, and, secondly, for the economy of the *main* supply. It is necessary to bear the relative importance of reliability and economy in mind, when considering which system to adopt, and to face the sacrifice of running economy of the auxiliary plant to a material extent, if by so doing additional reliability is secured.

Auxiliary apparatus generally may be divided into:—

(*a*) Steam-driven auxiliaries.

(*b*) Electrically-driven auxiliaries.

After making a careful balance-sheet of the respective merits of steam and electrically-driven auxiliaries, it will be found that it is impossible to lay down any hard and fast rule which will apply to all cases or to all classes of auxiliary machinery, partly on account of the widely-different conditions under which the machinery has to operate, and partly on account of the effect which the general design of the station has on this question. For instance, the American practice of omitting economisers leads to the adoption of steam-driven auxiliaries exhausting into feed-water heaters, while, as economisers are almost universally installed in English and Continental practice, it follows that there is less gain to be derived from exhaust steam-feed heaters.* To adopt electrically-driven auxiliaries either involves that the capacity of the main generating units be increased by 10 per cent., or, as an alternative, that this amount of special generating plant be installed. In either case, the cost of the additional generating plant must be debited against electrical auxiliaries, as steam-driven apparatus merely requires the provision of the additional boiler capacity.

The running account will be made up of the capital charges resulting from first cost, of the repairs and attendance charges, and of the actual cost of fuel. In considering these along with the question of reliability,† it is convenient to arrange the auxiliaries in a steam station under the following heads:—

1. Boiler house drives—*i.e.*, stokers, coal and ash conveyers, economisers and fans.
2. Circulating and air-pumps.
3. Feed-pumps.
4. Exciters.

Dealing with these *seriatim*:—

1. It will almost invariably be found that, even apart from the question of reliability, it is best to adopt electrical driving for the machinery in the boiler house. The units are small, and, if steam-driven, wasteful of steam and expensive in repairs and attendance.

2. As to the circulating and air pumps, we are of opinion that here also electrical driving is preferable, save only in the case of stations having slow-speed reciprocating main engines, where the air pumps may with advantage be driven direct from the main sets. The circulating pumps have occasionally to be situated some distance from the station, in which case electrical operation is especially advantageous.

3. The feed pumps are a more difficult problem. They operate at variable speed, whereas all other auxiliary plant in the station operates at constant speed. In addition to this steam feed pumps have for years been standardised—their first cost is low and their reliability high. They are needed even when the boiler fires are banked, and when no plant is running in the station; and though this last argument is admittedly not a weighty one, it would appear desirable to put down steam-driven feed pumps for, at any rate, the first instalment of plant. That this system of having steam-driven feed pumps at the commencements and electrically-driven feed pumps for extensions has much to commend it is evidenced by the fact that it has been adopted in many cases both in this country and abroad.

From the foregoing it would appear that at any rate the major portion of the auxiliary plant under the first three heads should be electrically driven,* and before proceeding to discuss the question of exciters, it may be as well to consider the best way of obtaining and applying electricity for operating the auxiliaries already discussed. There are four obvious methods of driving electrically the auxiliary machinery:—

1. From the main bus-bars.
2. From the main bus-bars with a reserve battery.
3. From separate generating sets.
4. From separate generating sets, with the addition of a connection to the main bus-bars to meet emergency conditions.

Of these (1) is the simplest method, the objection being that a total failure of supply stops not only the main units, but the auxiliaries—thus extending the duration of the failure owing to the necessity of again starting up the auxiliaries before the main units can be got under way.

The second alternative has the advantage that the auxiliaries can always be kept running even though the main plant be shut down. It is, however, more complicated than (1), particularly in an alternate current station, as it involves the interposition of a motor-generator between the bus-bars and the battery.

The most flexible system is (3), especially when the station is of sufficient capacity to justify the erection of auxiliary generating units of reasonable size. There still exists the possible danger due to failure, this can either be met by the instalment of a battery or by taking current in case of emergency from the main bus-bars on the lines of (4). This latter method offers many advantages, as it is preferable that the motors installed should be of the polyphase type.

If polyphase motors be adopted, and if, as would appear desirable, steam feed pumps are installed in the first instance, then as continuous current is required for excitation both the feed pumps and exciters may be left out of consideration, and it is of less importance than it otherwise would be to guard against failure of the polyphase auxiliaries. It is therefore justifiable, with the ultimate adoption of (4) in view, to start the first instalment of a power station with polyphase auxiliaries operated though stationary transformers from the main bus-bars, without, for the time being, providing any alternative source of supply, the separate generating unit for operating auxiliary plant alone would not be installed until justified by the load. In other words, method (1) may be adopted in the first instance with the idea of ultimately arranging for (4).

There is a further possible method—an extension of the complete unit system—which possesses many attractions, though, so far as we know, it has not been used anywhere. It consists in driving the whole of the auxiliaries from the particular main unit which they serve by connecting stationary transformers direct to the alternator terminals, these transformers being of sufficient capacity to operate air-pumps, centrifugal pumps, stokers, induced draught fan, and even, if desired, feed pumps—all in permanent connection through a switch with the main unit. In starting up the switches controlling air-pumps and centrifugal pumps may be left in, and the field of the main generator excited. These auxiliaries would then start up with the main machine, just as if they were mechanically coupled or geared to it. Flexible connections would be provided so that motors, feed pumps, or induced draught fans could be used as spares for other sets, but normally each main unit would deal with its own auxiliaries, and would be independent of all others. The chief advantages offered are simplification and consequent saving in switchgear, and also, we think, increased reliability. It will be seen that the bus-bars are protected from any failure of the stationary transformer by the main machine switch. (See fig. 11.)

We come now to the question of excitation—one which has always attracted considerable attention. Numerous attempts have been made to run each exciter from the main shaft of its own alternator, but this method has not been generally adopted, chiefly due to the fact that in any variation of speed this variation and the variation of the exciting current have a cumulative effect on the bus-bar voltage, and this effect is heightened by the unstable nature of a small low-speed direct current machine. The authors are, however, of opinion that, with high-speed engines, and more particularly with steam turbines, any difficulties there are, may be readily overcome, and that the simple arrangement of coupling the exciter to the end of the alternator shaft may be safely adopted.

The modern practice of operating all switchgear electrically almost necessarily involves the use of a small battery. It is convenient to utilise this battery to excite the fields of the direct-coupled exciters; it may also be used as a spare to meet the possible failure of one of the exciters. Such an arrangement carried out, is shown in fig. 12. Here two batteries are installed, from one or other of which the exciter field current is normally supplied; but, should an exciter break down, the battery may be used for exciting the alternator direct. Two batteries are installed, so that there may be no variation of exciting voltage while one is being charged, and the batteries, in addition to supplying current for excitation and for operating the electrical switches, can feed the emergency lighting circuits throughout the station.

5.—Switchgear.

Every engineer who has had experience in the operation of a large station appreciates of what vital importance it is that the switchgear

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* In this connection it may be noted that the installation of economisers offers more attractions with mechanical draught than with natural draught; in the former case the temperature of the flue gases at the base of the chimney need not be considered, and as a consequence they may be deprived of more heat.

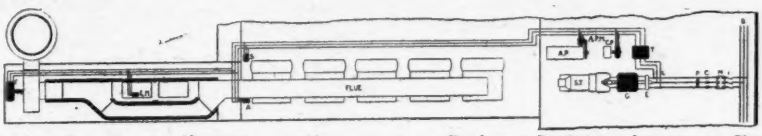
† This, in the case of all electrical auxiliaries, is more a question of reliability of the supply of electrical energy to the motors driving the auxiliary plant than of the plant itself

* The balance of advantages would still further lie with electrically-driven auxiliaries if it were possible to obtain efficient rotary feed and air pumps. There is no inherent difficulty in designing the former, and they have been installed in various places.

should be efficient and reliable under all conditions. We have already pointed out that the main bus-bars is one of the three places in the station where a junction must be made between the various units which, from the boiler house to the switchgear, may be kept completely independent of one another. Switchgear suitable for large power stations has only been recently developed, and on this account reliability of operation must be secured by a relatively heavy capital outlay. As the manufacture of high-tension switches and automatic protective devices becomes standardised and better understood, we may look for a reduction in first cost. In the case of switchgear it is capital expenditure only which affects economy of production; the actual charges for maintenance should not be high, and as for cost of attendance, this does not vary much for different types, though, of course, undue complication increases the running cost. On account of the absolute crippling of the power station which takes place if there be any serious failure of the switchgear, it is certainly justifiable to take every precaution to secure reliability even at the expense of capital expenditure. Under the section "Switchgear" we include not only the switchgear itself, but all electrical connections from the machine terminals to the main bus-bars, and from these to the outgoing feeders.

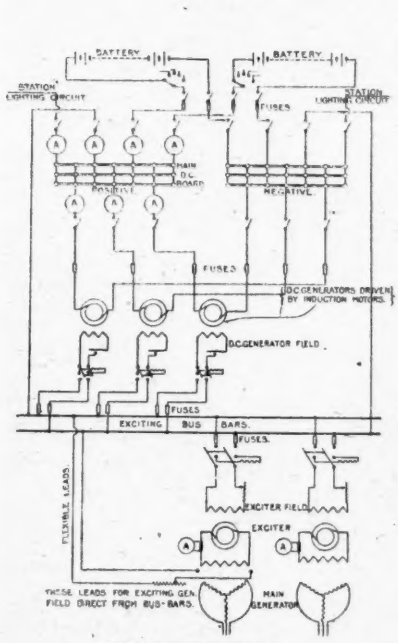
Reference to the drawings of two switchboards which have recently been installed will facilitate discussion of the essential points. Figs. 13 and 14 show the arrangement of switchgear designed and adopted by the authors at Carville, where British Thomson-Houston switches are utilised, and fig. 15 shows that for the five North-Eastern railway sub-stations, where Westinghouse switches are used.

Where large powers have to be dealt with, that is to say, where one switch may have to open 10,000 KW. or more, the serious effect of the failure of a switch, and the consequent necessity for completely sub-divided apparatus, will be readily realised. In both of the above designs this sub-division is provided for, not only between the various pieces of apparatus and connections, but, as may be seen from the drawings, also between the different phases of the main switch itself—in fact, the only place where two phases come together is in the potential transformer chamber. The whole board in each case is made of concrete* from 3 in. to 6 in thick. In designing the switch house building it is necessary that all material should be fire-proof, and this applies not only to the building itself, but as far as possible to all apparatus installed therein. The exigencies of space forbid a discussion of the details of each individual piece of appa-



A, Ash-handling motor; A P, Air-pump; A P M, Air-pump motor; B, Bus-bar; C, Current transformers; C P, Circulating pump and motor; I, Disconnecting link; E, Exciter; E M, Economiser motor; F, Fan motor G, Main generator; L, Link fuses; M, Main oil-switch; P, Potential transformer; S, Stoker motor; S T, Steam turbine; T, Transformer.

FIG. 11.—DIAGRAM SHOWING COMPLETE UNIT SYSTEM FOR OPERATING AUXILIARIES.



EXCITING CIRCUIT DIAGRAM. CARVILLE POWER STATION.

FIG. 12.

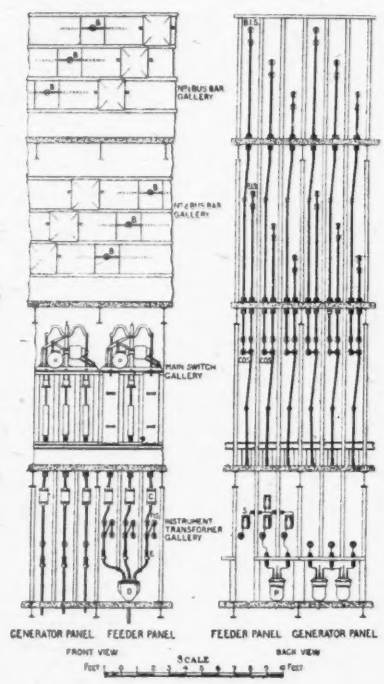
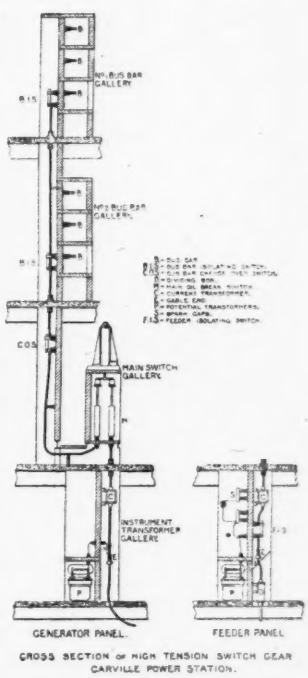


FIG. 13.



CROSS SECTION OF HIGH TENSION SWITCH GEAR CARVILLE POWER STATION.

FIG. 14.

As in other sections of a power station, reliability of supply is best met by adopting a systematic and simple design, and by properly sub-dividing all apparatus. Proper attention to the former will also tend considerably towards the reduction of capital cost, both in the first instance, and more particularly as the station grows—systematic design necessarily implying that due regard be paid to possible extensions.

The simplicity of the Ferranti single-phase board probably first directed the attention of engineers to the necessity for sub-dividing high-tension switchgear from the machine to the bus-bars, at the bus-bars themselves, and from the bus-bars to the outgoing feeder. Recent tendency in switchboard design* seems at first sight a retrograde step in the way of complication. The extra complication, however, is due rather to the fact that the system is a three-phase one† than that complication has been introduced. In fact, a modern board is practically a large Ferranti board controlled from a distance.

ratus, and as this paper deals more particularly with the assembling of apparatus rather than its design, we can only consider the requirements to be met, merely referring to apparatus without attempting to describe it.

In designing the station buildings, it was necessary to first decide upon the apparatus to be installed—in the case of the switchgear it is similarly necessary to decide upon the main switch, as the position of the terminals and the method of operation both affect the general lay out of the gear. It is now recognised that oil-switches are essential, and all high-tension circuits should be broken in this way—if only for the reason that opening the circuit under oil, puts so much

* See *Transactions American Institution of Electrical Engineers*, Vol. 18, "The Control of High Potential Systems of Large Power," by E. W. Rice, jun. See also "Three-phase Switchgear," by A. C. Eborall, *Engineering*, September 25th, 1903, *et seq.*

† Even if single-phase motors are largely introduced for traction or other purposes, it seems probable that three-phase generation and distribution will still be resorted to, on account of (*a*) cheaper machines, (*b*) cheaper and more easily insulated cables.

* In America, brickwork has been used for similar boards, but in the cases under consideration it was found that the adoption of concrete construction resulted in securing not only a cheaper, but certainly, in many ways, a better job. The first board of this type was, so far as we know, erected in the power station of the Metropolitan Street Railway Co., New York, but there the complete sub-division referred to has been carried out in the case of the bus-bars and the switches only, the connections themselves are not dealt with in the same way. Obviously the cost involved, forbids that similar precautions be taken in small sub-stations. It is, therefore, necessary to so arrange these small sub-stations with regard to the rest of the system that if a serious fault should occur in any one it is dealt with not by switches in the sub-station itself, but by the gear in the power station or in some large sub-station.

less stress on the cables and on insulation generally.* The switch chosen should be capable of breaking any current which may be met with in practice. This practically means, in emergency, breaking the whole short circuit capacity of the station. It is only, however, within very recent years that it has been possible to secure switchgear which will meet such a contingency.

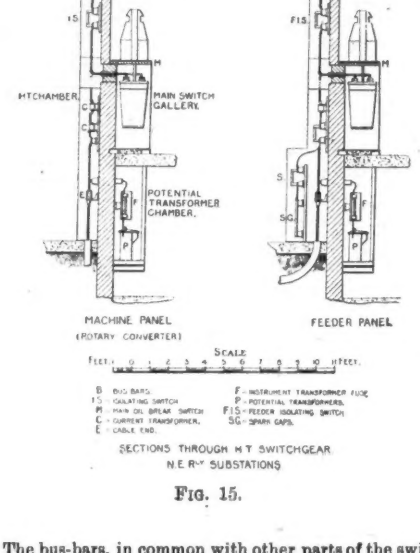


FIG. 15.

The bus-bars, in common with other parts of the switchgear, should not depend on fibrous or other combustible insulation. They may with advantage be of bare copper mounted on insulators, each bus-bar being separately enclosed in an independent chamber. The object of complete sub-division here, as in other cases, is to as far as possible avoid any serious trouble spreading and damaging the switchgear as a whole, should the switch by any chance fail to break a short circuit.

Obviously, in order to carry out without great expense, complete sub-division of the connections as well as of the bus-bars and switches, it is necessary to carefully consider the location of the switches in reference to the bus-bars, so that the former may be directly above or below the latter. In order to avoid all possible risk, it is essential that the switches should be next the bus-bars themselves, *i.e.*, that no apparatus of any kind should intervene between the switch and the bus-bars. Probably one of the greatest dangers to reliability of supply, and one likely to show itself prominently in the near future, is the excessive carelessness with which cables connecting machines or feeders to the switchboard have in the past been cramped together indiscriminately in a trench or tunnel. If big currents or large powers are to be conveyed, whether in a power station or under a motor coach, nothing short of complete isolation (or failing this several inches or feet of air space depending on the potential and power) will ensure freedom from failure, or keep the damage within proper limits in case of the failure of any part. It is not sufficient to attend to this point on the switchboard itself, it must be attended to from the machine terminals to the outgoing feeder. In the case of a power station it is unsafe to lay cables carrying large powers, whether high or low tension, even spaced some inches apart in tunnels or manholes, unless each cable is in its own duct, or in some other way protected by a properly earthed metal shield.† In order that these connections may be as far as possible completely sub-divided, the feeder or machine should preferably be kept directly below or opposite to the main switch. Between the switch and the machine or feeder cables the various transformers for the operation of instrument and relays should be installed. (See figs. 14 and 16.)

All instruments should be worked through transformers, thus greatly simplifying the alternating current switchboard problem, as recording wattmeters, power factor indicators, ammeters, voltmeters, and relays can be (and should be) supplied from one set of transformers—so reducing the complication on the main circuits to a minimum. Although by the above method the main connections are not complicated by the installation of additional instruments, yet for the sake of simplicity and saving in first cost the number of instruments installed, should be reduced to the lowest limit.*

(To be concluded.)

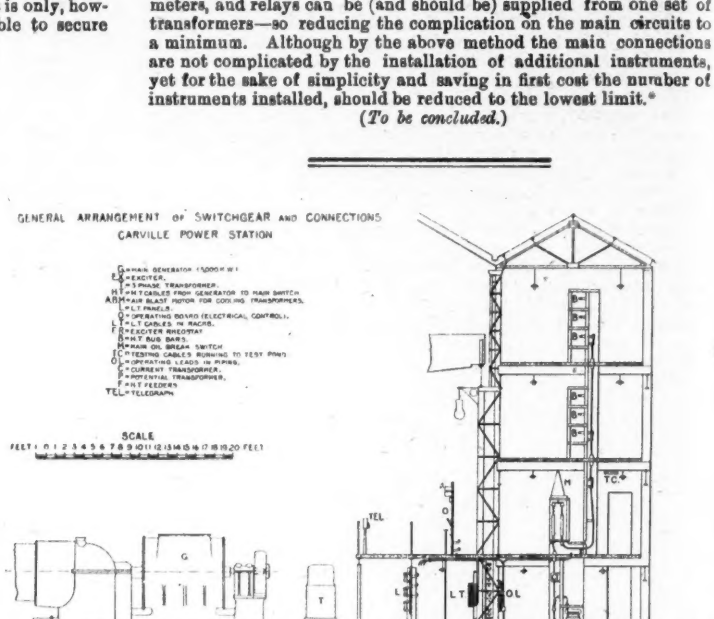


FIG 16.

PHYSICAL SOCIETY.

AT the meeting held May 6th, 1904, Mr. J. SWINBURNE, vice-president, in the chair, a paper entitled "Some Instruments for the Measurement of Large and Small Alternating Currents" was read by Mr. W. DUDDELL. The author described three thermal instruments which he has constructed for this purpose. The first instrument is essentially a sensitive Ayrton-Perry twisted strip ammeter, which is very quick in action for a thermal instrument, and has been used for observing and recording P.D.'s and currents which varied as rapidly as one per second. It is compensated for change in the surrounding temperature by forming the sides of the frame which holds the twisted strip with the same wire that the strip itself is made from. With the instrument exhibited, a current of 22 milliamperes gave a deflection of one-quarter the scale distance, *i.e.*, 250 mm., at 1 metre scale distance. The mechanical periodic time is only about $\frac{1}{15}$th second. Using this instrument in series with a high resistance, the author has made observations on the variations in the voltages of alternators caused by cyclic irregularity of the engine. By working to a false zero, it is easy to obtain 10 mm. change in deflection for 1 per cent. change in the P.D. The second instrument exhibited was a very sensitive thermal galvanometer called in the paper a "Thermo-galvanometer." It consists of the combination of a radio-micrometer of the "Boys" type, with a very small resistance, which is heated by the current to be measured, and which in turn heats the thermo-junction of the radio-micrometer by radiation and convection. The principle of its action is as follows:—A loop of wire has its two ends fixed to the two bars of a single thermo-junction, a mirror is fixed to the loop, and the whole is suspended in a magnetic field by means of a quartz fibre. The heat from the resistance raises the temperature of the thermo-junction and causes a current to flow round the loop, which is deflected by the magnetic field. The sensibility of the instrument depends on the resistance of the heater. Using a heater having a resistance of 13,910 ohms, a deflection of 250 mm. at a scale-distance of one metre is obtained with a current of 31 microamperes; a heater having 18 ohms resistance required 800 microamperes to give the same deflection. To illustrate the high sensibility of this instrument, the author showed the large deflections produced by the currents through a telephone receiver, even when the source of sound was many feet distant from the microphone; he also showed that if the thermo-galvanometer was placed in series with the vertical receiving wire in spark telegraphy over a short distance, large deflections were produced. The third instrument described was a switchboard instrument, which works on the same principle as the last

* Oil switches were first used for high tension currents by Ferranti in this country, and by Messrs. Brown, Boveri in Switzerland. Lately they have been developed (especially for large powers) by the General Electric Co., of America, and also by the Westinghouse Co.

† Three-core cables with a complete copper shield embracing all three cores should be used for these connections when earthed iron shields are inadmissible. In both this country and the United States it was until recently the universal practice to run bare lead-covered cables in manholes, with the natural consequence that in the event of one of the cables failing it was no uncommon thing for all the cables in the manhole to get damaged. The authors have known lead-covered cables give way due to an incandescent lamp lying against them. Arcs are frequently started between large power cables by the fusing of some minor wires—possibly pilot wires which had nothing to do with them.

* The following list gives all the instruments that are absolutely essential:—Machine Panel.—Main ammeter on one-phase, voltmeter for synchronising, field ammeter. Feeder Panel.—Ammeter on one-phase. The recording wattmeters may be put on the machines for the reasons stated later; it is safer to put the recording wattmeters on the machines than on the bus-bars, as the arrangement avoids any apparatus being connected with the bus-bar except through an oil-switch.

except that the moving part is pivoted in the usual way. The author exhibited one of these instruments, arranged to give the whole scale deflection for only 0·15 volt, which can be used in connection with shunts to measure large currents; for instance, to measure 1,000 amperes the power lost in the shunt would only be 150 watts. Transformers can also be used, as the power to produce the whole scale-deflection is only 0·3 watt. A similar instrument with a high resistance heater was also exhibited, giving the whole scale deflection for 0·1 ampere, which can be used as a voltmeter by putting resistance in series with it.

Prof. R. THRELFALL, in a letter to the secretary, congratulated the author on his instruments, and stated that the effect of change of relative position in the heater and thermo-junction during the operation of the thermo-galvanometer might make it possible to construct an instrument having a scale either of equal parts or of any desired form.

Dr. D. K. MORRIS pointed out that the working forces in an electrostatic instrument could be increased by limiting the angular range without increasing the moment of inertia of the moving system. For instance, this could be effected in a quadrant electrometer with a wide needle by sub-dividing the needle into narrow fingers, and sub-dividing the quadrants in a similar manner. Dr. Morris showed an instrument constructed on this principle capable of measuring 0·1 volt when used idiostatically. The limit to this process of sub-division is decided by the practical working clearance, the clearance being determined by the tilting of the needle due to unbalanced electrostatic forces. Such an instrument may be called a *multipolar electrostatic instrument*, and Dr. Morris has used the same idea in the construction of a *multipolar electrodynamic instrument*. Both of these instruments were exhibited at the meeting. Dr. Morris said that although they were well suited for use as zero instruments as detectors, they were not nearly so sensitive as the instruments designed by the author of the paper.

Prof. W. E. AYRTON drew attention to the fact that Mr. Duddell had not only designed the instruments, but had also constructed them himself. He was pleased to see that good results had been obtained by using an Ayrton-Perry twisted strip, the use of which had hitherto been limited by the absence of contrivances for compensating temperature change effects. Mr. Duddell had designed his thermo-galvanometer for use in an important investigation, being unable to purchase a suitable instrument. He asked the author if it would not be better in his thermo-galvanometer to double the heater on itself, and thus obtain a greater heating effect with diminished self-induction. Referring to the remarks of Dr. Morris, he said it was often difficult to calculate the sensibility of a quadrant electrometer with a divided needle. In order to do so, it was essential that the edges of the needles should never be near to the edges of the inductors.

Mr. A. CAMPBELL said that some years ago, in connection with the measurement of small alternating magnetic fluxes, he used a hot wire near a minute thermopile connected with an ordinary moving-coil galvanometer. One of the main difficulties with such arrangements was the slowness in reaching a steady deflection and in settling back to zero. For some relative positions of the thermopile and heater the deflection passes through its steady value, and creeps back to it; for other positions the steady value is reached asymptotically. Even in Mr. Duddell's instruments the effect is quite noticeable, and it appears to call for further elucidation.

Mr. K. EDGCUMBE could not follow the author when he said that his pivoted form of thermo-galvanometer would make a good switchboard intrument, because it was never necessary to measure small currents. In using Mr. Duddell's instruments, it was necessary to have very good contacts. He was not a believer in hot-wire instruments, which were unsuitable for central station work.

Mr. W. A. PRICE thought the instrument described by Dr. Watson in the discussion on Prof. Fleming's recent paper on a "Hot-wire Ammeter" in many respects would be more practical than those brought forward, although it would probably not be so sensitive.

Mr. W. BENNETT asked how far the temperature correction in the twisted strip was perfect. The sensitiveness of the radio-micrometer form of instrument would be increased if the efficiency of heat transference between the heater and the thermo-junction could be improved. He suggested using as a heater a thin film of platinum deposited on the inside of a small thin tube of glass or quartz.

Mr. R. S. WHIPPLE was of the opinion that a good deal of the bad name of hot-wire instruments could be attributed to their inability to stand overload.

Mr. H. TINSLEY, referring to Prof. Ayrton's remarks about the position of the needle in an electrostatic instrument, said he had recently tested the matter accurately. So long as the edges of the needle were well within the inductors, the instrument accurately followed a square law, and its working constant could be obtained from one observation.

The CHAIRMAN said that with regard to electrostatic instruments he did not see any advantage in being able to predict the deflection produced by any voltage, according to a definite law, as it was always easy to calibrate such instruments.

Mr. W. DUDDELL, in reply, said that it was necessary that the heater and the thermo-junction should be very small, and this made it difficult to diminish the self-induction of the heater by doubling it on itself. It was also essential that the bars of the thermo-junction should be narrow, otherwise creeping effects were introduced. The deflection might also be too small, due to the increase in resistance of the whole circuit brought about by the heating effect of the current. Referring to Mr. Edgcumbe's remarks, he pointed out that his pivoted instrument used less watts than any instrument on the market, and could be used if necessary in connection with transformer instruments.

Mr. F. E. SMITH exhibited and described the following instruments from the National Physical Laboratory:—(1) A mercury-resistance standard; (2) a 10-ohm build-up resistance box; (3) an astatic galvanometer.

An "Experiment with Lubricating Oils," by Mr. W. A. PRICE, was postponed.

AUTOMATIC PROTECTIVE DEVICES FOR ELECTRICAL CIRCUITS.

WE recently referred briefly to the experimental demonstration of automatic cut-outs, &c., given by Mr. Leonard Andrews at the offices of Messrs. Cowans, Ltd.; the following is an abstract of his remarks on that occasion:—

In the early days of electric lighting, reverse current automatic circuit breakers were so unreliable, that many engineers have hitherto preferred to trust entirely to fuses or to hand operated switches. The several serious breakdowns that have occurred during

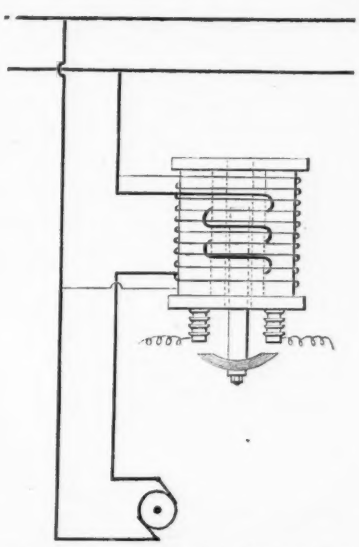


FIG. 1.—DIFFERENTIAL SOLENOID TYPE OF RELEASE.

the past winter, which it is generally recognised might have been prevented had the plant been controlled by reliable reverse current circuit breakers, have, however, again created a large demand for some apparatus that can be relied upon to isolate the faulty generator, and that will at the same time, under no conditions, cut off a generator that is doing useful work.

The designer of this class of apparatus is usually seriously handicapped by being unable to reproduce in the factory those conditions which occur at the time of a breakdown, and the station engineer, who has the opportunity of closely studying the matter, generally has so many other fish to fry that his attention is usually confined to giving instructions to "tie the beastly thing up."

During the past 10 years we have closely studied the behaviour of reverse current circuit breakers (both alternating and direct) under actual working conditions, and have investigated every

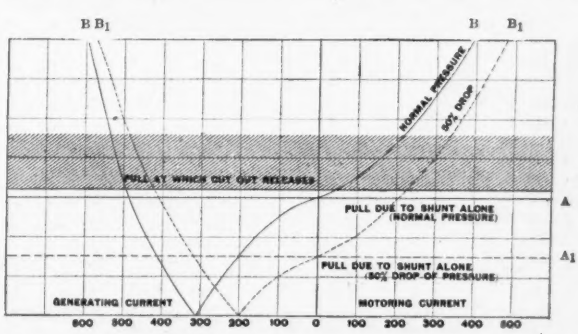

B B1
B B1
NORMAL PRESSURE
50% DROP
PULL AT WHICH CUT OUT RELEASES
PULL DUE TO SHUNT ALONE (NORMAL PRESSURE)
PULL DUE TO SHUNT ALONE (50% DROP OF PRESSURE)
A
A1
GENERATING CURRENT
MOTORING CURRENT
600 500 400 300 200 100 0 100 200 300 400 500

FIG. 2.

failure that has come under our notice, with the result that we have been able to locate the cause of failure in every case, and have been able to take steps to prevent its occurring again.

Failures due to Fall of Potential.—One of the chief difficulties arises from the general fall of potential that almost invariably takes place when a fault occurs on any part of a system of supply. We have in all our experiments always made a practice of taking records of the pulls given by different types of releases with both motoring and generating currents at various pressures across the shunt windings. These records we have plotted in curves, and we have thus been able to form an opinion as to the character of any type of cut-out by a glance at this curve.

Differential Solenoid Type of Release.—This type of release, illustrated in fig. 1, is one of the greatest offenders, both as to its susceptibility to variations of pressure and also to its small difference of cut-out pull with generating and motoring currents.

The characteristic curve of this type of release is reproduced in fig. 2. The generating current in the series winding is plotted horizontally to the left of central zero, and the motoring current to the right. The pull on the core due to the windings of the solenoid is plotted vertically. The horizontal line below the shaded area represents the point at which the cut-out is set to operate. The horizontal line A shows the pull due to the shunt winding alone at normal pressure. Curve B reads the pull for currents of different

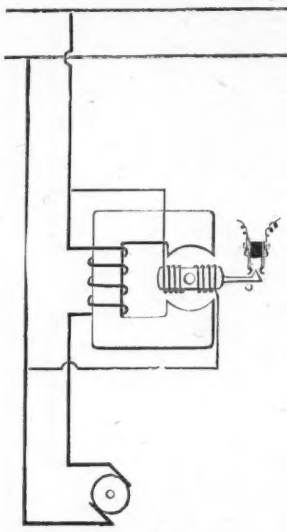


FIG. 3.—MOTOR TYPE OF RELEASE.

values, both generating and motoring, with the pressure across the shunt maintained at normal. It will be seen that this curve enters the shaded area with a motoring current of 50 amperes, and with a generating current of approximately 500 amperes, the ratio of the motoring current to the generating current being about 10 to 1. If now the pressure across the shunt falls to about 50 per cent. of normal, the pull due to the shunt alone may be represented approximately by A_1, and the combined pull due to the shunt and series is shown in B_1. It will be seen that the ratio of the generating

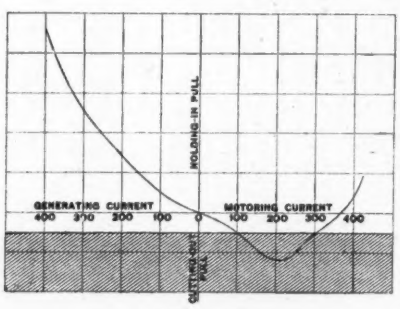


FIG. 4.

current to the motoring current on this pressure is less than two to one. It is thus obvious that with any appreciable variation of pressure this type of cut-out ceases to become a reverse current circuit breaker and becomes an excess current device. It will in consequence almost certainly be operated by an excess current on the feeders, and will even cut out a healthy generator just at the time when every sound generator is required to "bang on" for all that it is worth.

Attention was drawn to this defect in a paper on "A few Practical Notes on Alternating Switchgear," before the Northern Society by L. Andrews in January, 1897.

Motor or Wattmeter Type of Release.—The troubles experienced with the differential solenoid type of release referred to above, appear to show that the pull tending to release a reverse current circuit breaker should be in one direction for a motoring current, and in the reverse direction with a generating current, or failing that, should have no appreciable pull with any amount of generating current.

One method of attaining this result is shown in fig. 3. A few turns of thick wire connected in series with the circuit to be controlled are wound on the field magnets of a miniature motor, and a number of turns of fine wire connected across the leads of opposite polarity, are wound on the armature. It will be obvious that when the current in the series winding is flowing in a certain direction relative to that of the shunt, the armature will tend to rotate in a clockwise direction; movement in this direction is, however, prevented by a stop. Should the direction of the series current become reversed, the armature will rotate in a contra-clockwise direction, and will thus release the circuit breaker, either directly or by closing a local circuit through the operating coil. It can only, however, be relied upon to do this so long as the armature is set at right angles to the direction of the field. There is, of course, always a risk with this type of cut-out that something may occur, such as a screw working loose, to alter this fine setting. Should the change of adjustment cause it to take a lead in a contra-clockwise direction, the effect of a heavy current in the series winding will cause it to rotate further in this direction, and so pull the cut-out. As this is most likely to occur at the time of full load, or when the generator is required to supply a momentary excessive current to isolate a fault on a feeder, cutting out the generator at this time is liable to be disastrous. To deal with this difficulty it is usual to give the armature a slight lead in a clockwise direction, so that a heavy current in the series winding will tend to hold the cut-out in, rather than to release it. This precaution introduces, however, another difficulty.

If a reverse current is applied slowly, the cut-out will operate perfectly with possibly 5 or 10 per cent. of the full load current. But if the series current is suddenly reversed from a heavy generating current to a heavy motoring current—and such sudden reversal is always liable to occur when a generator breaks down—and if this heavy reversal is accompanied by an appreciable drop of pressure, the tendency of the armature to turn in a clockwise direction, thereby reducing the reluctance of the magnetic circuit, is so very much greater than the tendency to turn in a contra-clockwise direction, due to the polarity effect, that there is always a risk that this type of cut-out may fail to isolate a generator that suddenly fails. The characteristic curve of this cut-out is reproduced in fig. 4. It will be seen that with a generating current the pull tending to prevent the relay from closing increases as the generator current increases; that is to say, the curve gets further away from the shaded area. With a small motoring current the curve drops into the shaded area and operates the cut-out; when this current is appreciably increased, the curve doubles back and leaves the shaded area, and any further increase of current tends to more securely prevent the cut-out from operating. This defect is considerably augmented if the increase of current is accompanied by an appreciable fall of pressure.

It will appear at first sight that there are many simple ways of getting over the difficulties referred to above, but we have found, in the many modified arrangements we have experimented with, that, in the majority of devices, the particular difficulties referred to were only overcome at the expense of the introduction of other difficulties equally or even more formidable.

Pendulum Relay Type of Release.—It is evident that the chief cause of the reluctance effect overcoming the polarity effect of the above device is that an attempt has been made to use a nearly closed iron circuit.

If solenoids are used to act upon an armature without a return magnetic circuit, a reliable relay may be made that entirely overcomes all the difficulties referred to above. A device of this description consists of a swinging T-shaped pendulum polarised by a fine wire solenoid, and the free ends of this swinging armature are acted upon by two heavy coils carrying the series current. It is obvious that, with the current in one direction, the armature will be pulled in such a direction as to hold the relay contacts open, whereas, with a reverse current, the relay contacts will be closed, and the circuit breaker released. One of these relays, connected up in circuit with one of our standard circuit-breakers, has no tendency to be operated by a heavy forward current, while, on the other hand, it operates both with a small reverse current, and equally reliably with a heavy reverse current, and with a pressure as low as 25 per cent. of the full load pressure. The device appears, in fact, to be quite satisfactory as a relay.

Direct Acting Reverse Current Release Types.—Although we have, as indicated above, found no difficulty in constructing a reverse current device to act reliably as a relay, there are some obvious advantages in making a circuit-breaker direct acting. As the blow required to release a large circuit-breaker must be considerable, it appears almost impossible to attain this with a reverse current of less than 25 per cent. of the normal current without the aid of a closed iron circuit, and in the majority of closed iron circuit devices we have been obstructed by the difficulty above referred to overpowering the polarity effect under certain conditions. We have, however, recently succeeded in making a closed magnetic circuit device that is in no way subject to this difficulty. This device is illustrated in fig. 5. It will be seen that it is constructed on the lines of the field magnets of a Manchester type dynamo.

The series and shunt windings are so connected up that under normal conditions—that is to say, when the generator is doing useful work—the fluxes will flow through the field magnet limbs in series, avoiding the centre path through the movable core and air-gap. Should the series current become reversed relatively to the shunt current, the fluxes in the field limbs will flow in parallel through the centre path, producing a strong field across the air-gap, and lifting the movable core with considerable force, and thus directly releasing the circuit-breaker without the intervention of a relay. The characteristic curves of this type of release are reproduced in fig. 6. It will be seen that at normal pressure a motoring current of 33 ampere-turns is sufficient to operate the cut-out, whereas with a generating current of 10,000 ampere-turns the pull on the core is practically immeasurably small. It will also be seen that this type of cut-out is not highly susceptible to a drop of potential across the shunt windings, as with 50 per cent. of the normal potential the cut-out operates with only 50 ampere-turns, and still shows no sign of releasing with 10,000 ampere-turns generating current. By using a cast-steel core in the shunt winding, this core retains residual magnetism long enough to operate the cut-out, even should the potential fall to zero.

Alternating Current Discriminating Devices.—All the devices referred to above may be used for alternating current circuits. But other difficulties are here met with that do not arise in connection with direct current systems. One serious difficulty common to nearly

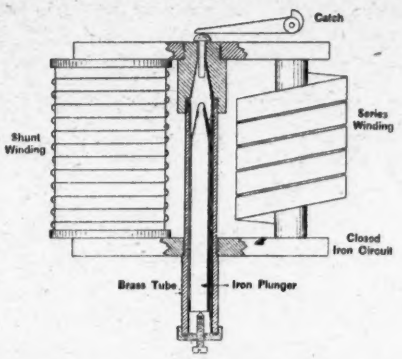


FIG. 5.—DIRECT ACTING REVERSE-CURRENT RELEASE.

all alternating current devices is, that in addition to the troubles which are liable to arise through the drop of pressure across the potential winding owing to external causes, a further reduction of the shunt current takes place owing to the inductive action of the series winding in the cut-out device upon the shunt winding. We have found, for instance, in some types, that on passing a very heavy current from the series winding, the current in the shunt winding due to the applied E.M.F. is entirely wiped out by the secondary

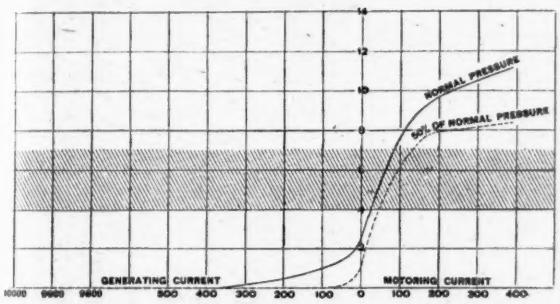


FIG. 6.

current due to the inductive action of the primary current, and as a consequence the device loses all sense of direction. It is obvious that this defect would be particularly apparent in the type of release illustrated in fig. 5. We at one time almost despaired of making an alternating current cut-out that entirely overcame this and some other difficulties. The device which we are about to describe appears to have done so; we can at least say that during the two years devices of this type have been in daily use, they have not up to the present developed any niggers.

(To be continued.)

THE ART OF SPENDING OTHER PEOPLE'S MONEY.

[COMMUNICATED]

UNFORTUNATELY for the community at large, the above title is not the result of any imaginative effort upon the part of the writer. It was naturally and easily suggested by the present condition of affairs, both under the auspices of municipal management and in the hands of limited companies.

With regard to municipal trading, it is some relief to learn that Government authorities are at last awake to the fact that ratepayers are sadly in need of protection from the extravagant expenditure of their money which has been in progress for some years past.

Members of electric lighting, telephone, and tramway committees have long held, as it were, the ratepayers' blank cheques, and have engaged in municipal trading on their behalf in a spirit of optimism which has been sadly marked by a deplorable want of judgement and knowledge of the matter at issue.

Cities and towns in all directions have rushed into municipal trading, always starting with the assumption that the scheme must prove a successful one, however unwarranted, and however lacking in a basis of careful investigation, such an assumption might be.

Not long since a member of a telephone committee in one of our large towns stood up and boldly assured those present that the scheme he advocated was bound to pay handsomely; in fact, so confident was he, that he was prepared to make up any deficit which might arise out of his own pocket. Such painful folly as this well illustrates how little the majority of those representing the ratepayers' interests realise the responsibility which rests with them, and how little they grasp the fact that thousands may grow into tens of thousands, or tens of thousands into hundreds of thousands, when once an ill-considered scheme is entered into.

Perhaps the most deplorable aspect of the question is the light-hearted spirit of extravagance which characterises the municipal attitude.

It is, of course, due to lack of personal interest and responsibility; the persons who so lightly vote for the expenditure of tens of thousands of pounds are simply *spending other people's money.*

The Town Council of one of our large seaside resorts recently decided that it would suit them to have a municipal telephone system. The writer puts it in this way, as he is quite convinced that the various gentlemen responsible for the decision were absolutely (and naturally) incapable of forming a reliable opinion as to the chance of the scheme paying.

Not content with laying a duplicate system of lines throughout an area already well served by the National Telephone Co. at fair rates, they actually extended their system to a small town about 5 miles from their boundaries. The small town in question is a sleepy old-fashioned place where the demand for telephones is extremely small, and the prospects of development practically nil. We have, therefore, the following stupendous piece of folly before us:—On one side of the main road connecting the two towns, is a row of gigantic and hideous poles belonging to the National Telephone Co., carrying about 20 lines, but with capacity for 100 at least. On the opposite side of the road is another row of poles equally gigantic and hideous belonging to the corporation in question, and carrying *two* lines. The writer has been anxiously looking for the appearance of a third line for some months past, but in vain.

Not realising the painful and costly absurdity of such a state of affairs, the corporation actually propose to do exactly the same thing with regard to another town about 10 miles from their boundaries, and where the possibility of paying business is equally remote.

Unfortunately for the inhabitants, the corporation of which the writer speaks, do not confine their business efforts to competing with the National Telephone Co. They have been aptly described as one of the largest municipal trading concerns in the kingdom, and such is the case, lamentable though it is proving for the ratepayers. They are also the proud possessors of a fine modern system of electric tramways which carry the delighted ratepayers quite fabulous distances for the distinctly moderate charge of one penny.

It may, perhaps, not be considered a descent into trifling matters if it is remarked here that the first two years or so of working showed a very heavy loss, that is to say, by all canons of fair book-keeping and business methods. That detail has, however, been satisfactorily disposed of (for the present) by some occult system of figures known only to those within the magic ring of municipal affairs.

Turning from the municipal side of the question, we find much that is to be regretted in the ways and means of limited companies. Again and again one sees a comparatively small but prosperous business, run upon economical lines as regards rent, expenditure upon buildings and management, suddenly changed under the influence of a great influx of capital. Large and costly buildings are erected, quantities of elaborate machinery installed (some, by the way, destined to work one day per week), whilst management expenses go up by leaps and bounds. Those responsible for the change always seek to justify their action by urging the necessity of "moving with the times," and state their full conviction that the business will expand in proportion to the expansion of the works. This desirable consummation does not, however, always follow, and frequently the edifice topples and falls to the ground, the victim of that most disastrous of business complaints—over-capitalisation.

The writer is personally cognisant of a number of unobtrusive and economically conducted factories, whose net profits would be a revelation to the long-suffering shareholders in the top-heavy class of concerns alluded to.

SOUTH AFRICAN NOTES.

[FROM OUR DURBAN CORRESPONDENT.]

Durban (Natal).—The acting borough electric engineer's report for the month ending April 30th, states that the number of lamps applied for was 2,372, making the total applied for to date 109,249. The number of applications for current was 48, and the number of connections actually made was 78, making the total number of consumers 2,405. The number of units consumed for private lighting was 119,157, which is an increase of nearly 21,000 over the previous month. The street lighting has been added to by 37 incandescent lamps, making the total 804; and 14 old arc lamps which were originally run from the Point works have been replaced, and 25 enclosed D.C. lamps substituted in their place; these are now connected to the 500-volt supply. The power connections are also growing, eight new connections having been made, which brings up the total to 131, and the number of units consumed for such purposes being 51,101.

In connection with the telephone work 3,500 ft. and 3,550 ft. of 3 in. and 3½ in. cast-iron pipes have been laid, also 250 ft. of 14-way conduit, and 13 of the manholes have practically been completed.

At the power station the fifth large cooling tower is now approaching completion, and it is hoped during the next month to put it into operation.

Pietermaritzburg (Natal).—A meeting of those interested in

science was held here on May 3rd, and included a large number of Government experts. The chief object of the meeting was to consider the advisability of forming a branch of the South African Association for the Advancement of Science, and a working committee was appointed; it includes the superintendent of education.

Heidelberg (Transvaal).—It is reported that among other schemes before the Town Council is one for providing the town with an electric lighting plant.

East London.—The six cars referred to in our "South African Notes" in the issue of March 18th last, are, no doubt, intended to refer to the East London tramways, and we hear from Mr. Cuthbert W. Moores, the borough electrical engineer there, that six double-deck cars, with Milnes-Voss glazed roofs are on their way out, having been constructed by Messrs. Dick, Kerr & Co., who are also supplying the rails for the two miles extension (which His Excellency the Governor of Cape Colony has consented to), and a 200-KW. Belliss traction set. Powers for a further mile are being sought, and the work of laying the two miles referred to is being started at once by the contractors, Messrs. Strong and Moore, of Durban. The total revenue from the trams in 1903 was £15,060.

Kalk Bay (Cape Colony).—The first reading of the Kalk Bay Electric Light and Power Bill was passed in the Select Committee of the Cape Parliament on April 26th.

Pietermaritzburg (Natal).—Mr. P. Finlayson, the lately appointed tramway manager to the Pietermaritzburg Corporation, in drawing up his report on the system which is now being installed, refers to many matters which need alteration, and the T.C. have decided to adopt his suggestions. He considers that the cars under order are unsuitable, and he has advised the purchase of six double-deck cars with a seating capacity of from 40 to 47 persons, instead of as originally 68 persons. The body breadth is to be 8 ft., or not more than 9 ft. over all, with large windows, low sills, sliding sashes, louvre blinds and end and side curtains. The seats are to be of the "reversible garden" type, and the staircase is also to be reversible. The truck is to be of the four-wheel type, with a wheel base of 6 ft. 6 in. The equipment is to be of the Westinghouse type, and a "Sterling" hand and rheostatic brake is to be fitted, the trolley to be of Brecknell, Munro & Rogers's make. Mr. Finlayson urges the immediate extension of the line to the Botanical Gardens, which will form an extra to Messrs. Strong & Moore's contract. The carsheds now in course of erection can be easily altered at an additional cost of £200, to take 18 instead of 12 cars. The track work has been very well laid, but the 95-lb. rail for girder track he considers excessive for the requirements of Pietermaritzburg, and he recommends an 85-lb. rail for all future extensions. The adoption of the Vignoles rail for the line to Scottsville is, in his opinion, a mistake, and he advises that in future such rails should only be laid where the line passes through roads not likely to be built on. Further "turn-outs" are required to provide for the 10-minutes' service to the Town Hall. The poles are too costly, and fixed too closely together, and he considers that placing them 120 ft. apart is sufficient, and the rails instead of being cross-bonded at every pair, should be so bonded at every third pair. A track "sprinkler" of 3,000 gallons capacity is required at once, at a cost of not more than £1,000, fitted with Westinghouse compressor and equipment, and rheostatic, magnetic, and "Sterling" hand brakes, the truck to be of the maximum bogie type; it will be required to work on a grade not steeper than 1 in 16. A tower wagon is also required, at an additional cost of £200. After considering the manager's report, the Town Council have practically endorsed his opinion, and have cabled for cars and sprinkler as suggested, and will extend the track and carry out other alterations, the additional cost involving an expenditure of about £12,000.

Port Natal.—The Port Advisory Board at their meeting on April 29th, had a discussion on hydraulic *versus* electric cranes; it is clear that the hydraulic cranes are unsuitable for the growing demands of the Port, which is now capable of admitting the large Mail boats, and if electric cranes are introduced, they will have to be installed over the whole of the wharves, and opinion is generally understood to be in their favour.

Another correspondent writes:—

Cape Colony.—In the Town Hall of King William's Town, which has been practically rebuilt, the electric lighting has been carried out by Messrs. Ryan & Petersen, under the superintendence of their manager (Mr. Ancell), the scheme having been drawn up by Mr. E. G. Clifford Jones, late consulting engineer to the King Electric Lighting Co.

Port Elizabeth is still patiently waiting for its streets to be lighted by electricity. The local *Herald* thinks the T.C. cannot be congratulated on the progress which has so far been made with the project.

At East London a large electric power station is being built for the purpose of supplying all electric light and power needed in the harbour.

Orange River Colony.—In Bloemfontein the proposal to supply a day current seems likely to fall through. The committee concerned with the matter recently reported to the T.C., that "An electric day current would come into competition with oil engines," and that "the cost of working oil engines of 10 HP. is 1s. per hour, as against 3s. 6d. per hour for electric energy of 10 HP. The number of applications which would be received would not warrant the additional outlay by the Council," and the Committee accordingly recommend that the matter be suspended.

Natal.—There was a partial failure of the electric light in Maritzburg on the night of May 3rd, involving an adjournment of the Legislative Assembly. The failure was due to a breakdown at the sub-station in Commercial Road.

At Potchefstroom a special meeting of the Electric Lighting Co. was recently held. Mr. Galsford presided, and it was unanimously decided to increase the capital of the company from £6,000 to £12,000, to make provision for the carrying out of the contract for the street lighting, the tender for which has been accepted by the municipality. The chairman's report showed that the new plant, &c., would cost about £5,000, and Mr. Slade, one of the directors, stated that the profits were being devoted to the increase of the plant.

EW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

11,219. "Switch for electric signs." F. NUSCH. (L. Hölscher, Germany.) May 16th. (Complete.)

11,238. "Improvements in electric meters for three-phase alternating electric circuits." THE UNION ELEKTRICITATS-GESELLSCHAFT. (Date applied for under Patents Act, 1901, May 15th, 1903, being date of application in Germany.) May 16th. (Complete.)

11,237. "Formation of an acid or electrolyte from water." A. BLACKMAN. May 16th.

11,251. "Improvements in voltmeters used in connection with distributing mains or feeders for systems of electric-current supply." G. M. NEWBERY. May 16th.

11,262. "Method for the transmission of sound to long distances and telephonic apparatus therefor." V. TARDIEU. May 16th. (Complete.)

11,272. "Improvements in electrical safety apparatus for signalling on and controlling trains independently of driver." J. W. MACKENZIE. (The Société Cousin & Co., France.) May 16th. (Complete.)

11,274. "Improvements in telephone selecting systems." W. D. WATKINS. May 16th. (Complete.)

11,284. "Improvements in counterweights for electric light fittings and the like." H. HIRST and J. H. COLLINGS. May 17th.

11,288. "Improvements in electric accumulator electrodes or plates." A. RICKS. May 17th.

11,359. "A damping arrangement for the index vibrations of electrical measuring instruments." A. FLEISCHMANN. May 17th.

11,363. "Improvements in or relating to apparatus for use in the distribution of alternating currents." A. F. BERRY. May 17th.

11,368. "Improvements in electric switches suitable for use in connection with telephonic apparatus and for other purposes." E. A. GRAHAM. May 17th.

11,390. "Improvements in hangers for suspending overhead trolley wires or other conductors of electric current." H. BRECKNELL and BRECKNELL, MONRO AND ROGERS, LTD. May 18th.

11,405. "An automatic electric switch for the intermittent lighting of electric lamps or group of lamps." C. T. POUNSFORD and F. T. LOVE. May 18th. (Complete.)

11,439. "Improvements in or appertaining to incandescent electric lamps." D. J. O'BRIEN. (Date applied for under Patents Act, 1901, May 25th, 1903, being date of application in United States.) May 18th. (Complete.)

11,443. "Improvements in electrical ignition apparatus for internal combustion engines." J. LEIGHTON and R. HACKING. May 18th.

11,444. "Improvements in and relating to dynamo-electric machines." THE BRITISH THOMSON-HOUSTON CO. (The General Electric Co., United States.) May 18th.

11,447. "Improvements in dynamo-electric machines." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) May 18th.

11,448. "Improvements in and relating to electric switches." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) May 18th.

11,449. "Improvements in coil-winding apparatus." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) May 18th.

11,470. "Improvements in or connected with the poles or electrodes of electrolytic apparatus and the like." G. J. ATKINS. May 18th.

11,471. "Improvements in dynamo-electric machines." SIEMENS BROS. AND CO., LTD. (Siemens & Halske Actien Gesellschaft, Germany.) May 18th. (Complete.)

11,481. "Electric light fog signal." R. P. SKINNER. May 19th.

11,531. "Improvements in and relating to electric controllers or switches." THE BRITISH THOMSON-HOUSTON CO., LTD., and A. H. CUBITT. May 19th.

11,568. "Improvements in or relating to electric current switches." J. HALL and A. HACKBLOCK. May 19th. (Complete.)

11,574. "Improvements in electrical thermostatic apparatus and similar instruments." P. HENSEL. (O. Rennert.) May 19th.

11,595. "Knocking off finger arrangement for electric slubbing intermediate and roving frames at any pare of the lift." E. GOULDING. May 20th.

11,604. "Improvements in dynamo-electric machines." L. WILSON. (Date applied for under Patents Act, 1901, June 1st, 1903, being date of application in United States.) May 20th. (Complete.)

11,649. "Improvements in or connected with incandescent gas, acetylene and electric arc lamps." H. WINKLER. May 20th.

11,650. "Improvements in or relating to incandescent gas, acetylene and electric arc lamps." H. WINKLER. May 20th.

11,651. "A portable insulated support for double wire electric lines." A. COLLET. (Date applied for under Patents Act, 1901, August 4th, 1903, being date of application in France.) May 20th. (Complete.)

11,665. "An improved distributing switch, chiefly designed for use in high-tension electric ignition gear for multiple cylinder explosion engines." L. A. GIANOLI. May 20th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1903.

ELECTRIC BATTERIES. J. Portalier. 5,891. March 13th. (Date applied for under Patents Act, 1901, September 13th, 1902, being date of application in Belgium.)

A SWITCH FOR USE IN CHARGING STORAGE OR SECONDARY BATTERIES. W. G. Heys. (The Hutchinson Acoustic Co., United States.) 5,918. March 14th.

ELECTRIC SPARKING DEVICES ESPECIALLY INTENDED FOR FIRING THE CHARGES IN INTERNAL COMBUSTION ENGINES. E. F. Bradley and H. Edmunds. 5,989. March 14th.

ELECTRICAL FUSEBOARDS. J. Moores and D. Ashton. 6,016. March 16th.

ELECTRICAL SWITCHES, KNOWN AS TUMBLER SWITCHES. G. Sperryn and W. R. Wood. 6,249. March 18th.

ELECTRIC CONTROLLERS. H. von Kramer. 6,327. March 19th.